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THE CANAL CONNECTING THE NORTH SEA WITH THE BALTIC SEA.

THE immense structures on the great German ship canal are nearing completion. This canal will connect the waters of the North and Baltic Seas where they wash the coast of Germany, and will serve as a means of intercourse for the vessels of the German navy as well as for those of the merchant marine. It is already evident that the canal will be completed and open for use by the time agreed upon, the summer of 1895, allowing only eight years for the whole construction, including the preparatory work.

In building the canal no abnormal land formations, no rushing mountain torrents, nor mountains of rock have interfered with the progress of the work, as in the case of the Panama canal, for instance. The region through which the future waterway is to pass contains no land higher than about 80 ft. above the level of the sea, and the ground is for the most part sandy or marshy, the only real difficulties in the way of the formation of a normal canal bed being those presented by the bogs and quagmires, which are especially numerous in the western portion. But as these are being treated by the proper methods, they have caused no delay, and now the line is ready in the rough throughout almost the entire length, 61 miles, from Kiel to the lower Elbe. The general width of the canal is 196 ft. 10 in., but in some places it is 328 ft. wide, thus allowing space for vessels to pass one another. The greater part of the canal is already filled with water, and as soon as it has been deepened it will be ready for the passage, at a speed of about 6 miles an hour, of the largest commercial steamers and men of war, which have a displacement of 13,080 cu. ft.

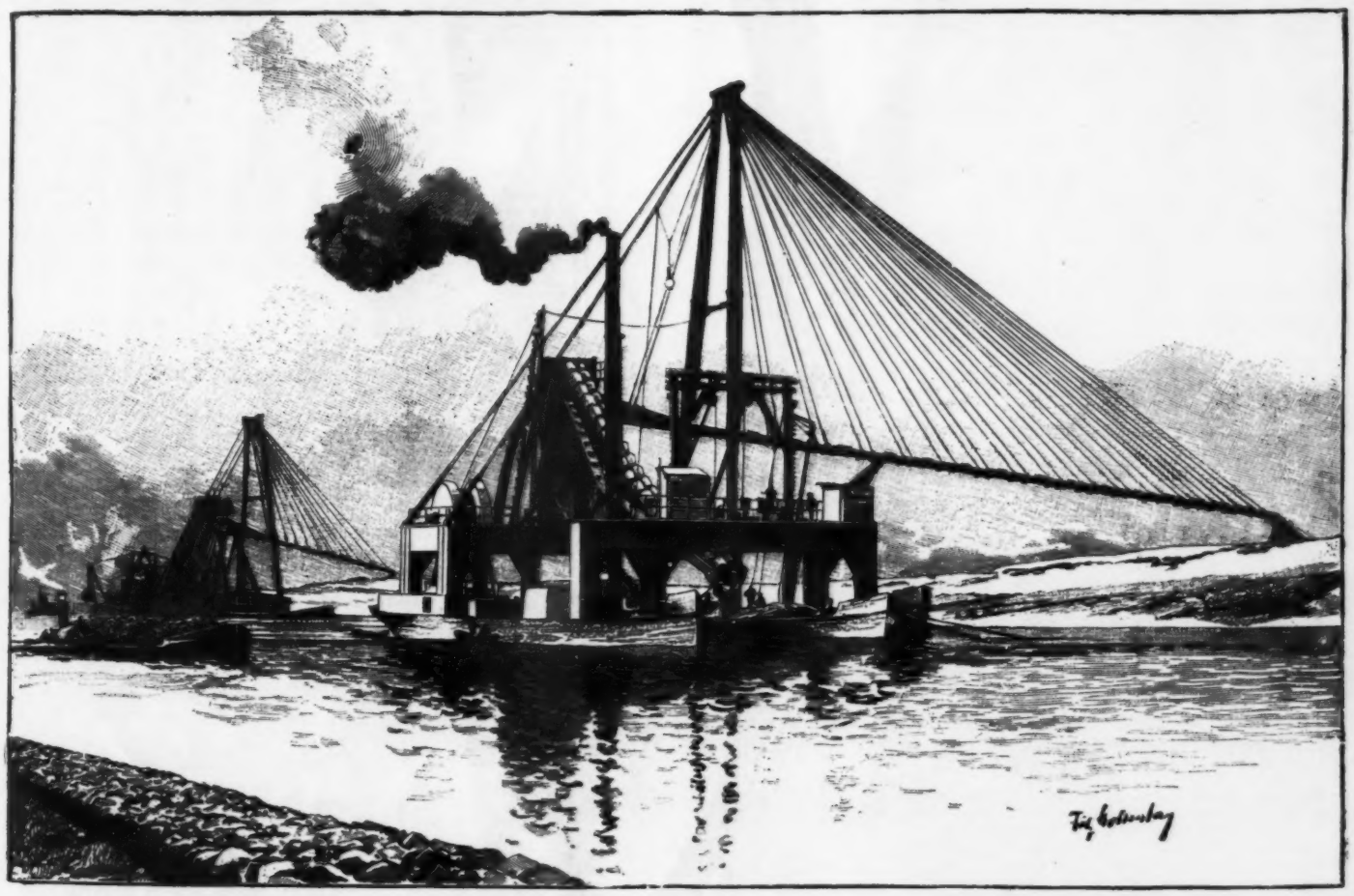
This work is being done by floating dredging machines, which loosen the bed of the canal by means of heavy metal buckets on endless chains, that raise the material and dump it into scows. Dredges of this kind, for raising great masses of earth—in the case of the North-Baltic Sea canal over 102,024,000 cu. yds. had to be removed—are comparatively simple in construction, but when they are intended for work on boggy, miry ground, as in the western portion of the canal and where it runs parallel with the lower Eider, they have to be differently constructed, arrangements being made for moving the raised material from the dredge to the dumping ground more rapidly than when solid, sandy and clayey bottoms are to be manipulated. Our illustration, entitled "Floating Elevators at Schulp," shows the machines in operation. The boggy ground mixed with water is raised by means of bucket chains and is then pressed by steam power through a long pipe that extends sidewise from the elevator and carries the mixture to the desired place, where it issues from the mouth of the pipe in the form of liquid mud. When approaching the working ground the frame and the wire cables and chains that support the piping are visible at a distance. These dredges are provided with their own electric lights, and when working at night cause a strange impression.

These machines constitute the special feature of the work in the low-lying portions of the canal—part of which is below the level of the sea—but where it cuts through the low ridges, near Grunenthal in the western and Levensau in the eastern portion of the line, two durable structures demand consideration. These are two iron bridges which span the bed of the canal with wide arches and are rightly called "high bridges" on account of the height of their floors above the surface of the water in the canal. On each of the bridges there is a railroad, a driveway, and a promenade; the one near Grunenthal was in use last winter, while they are just beginning work on the one near Levensau. In one of our engravings we give a view of the place, near Grunenthal, where the completed bridge spans the bed of the canal, which has not yet been entirely excavated. The supporting iron structure consists of a single slender arch, the roadway being partly carried by and partly suspended from it. To reach from bank to bank a light span of 510 ft., the longest in Germany, was required. A long and high embankment—containing nearly 2,616,000 cu. yd. of earth—on each side of the canal carries the railroad so high that the floor of the bridge will be 137 ft. 9 in. above the surface of the water in the canal, and the largest full-rigged merchant and war vessels can pass under it at full speed by simply lowering their topmasts. A passenger in a car on the bridge may see a mighty ship far below him, while the pennon on the mast will be almost within his reach.

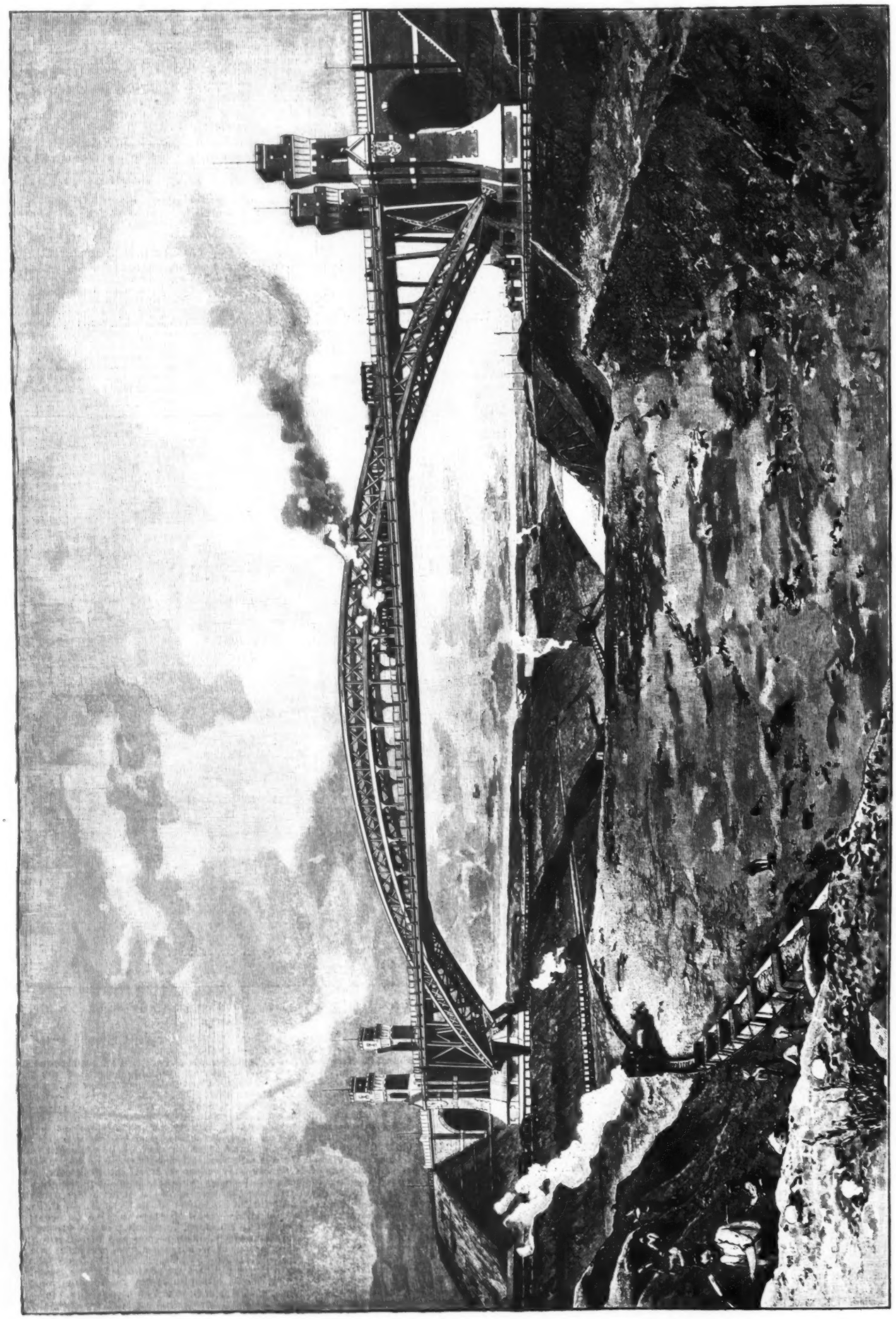
Our illustration shows the bridge after its completion, the ends resting on strong piers of masonry crowned with tower-like gates. The royal eagle decorates the sides of the piers, which, as well as the iron parts of the bridge, are built entirely of German material. The iron work was made by a Nurnberg firm at a cost of $11,900,000. The different parts were put in place by numerous electrical machines driven from a central station. Those parts of the piers that needed to be specially strong are of Rathenow stone, while Bavarian blue granite was used for the socles and bearings. The great coats of arms with the royal eagle are of Oberkirchen sandstone. Materials from far inland have been brought together in this imposing structure on the northern border of the realm.

The immense locks at the ends of the canal, both on the lower Elbe and the Baltic Sea, constitute a very important feature of the construction. Such locks have never been made before. Although there is seldom any great difference between the flood and ebb on the Baltic, perhaps not oftener than twenty-five times a year, a lock had to be built here, for if this is to fulfill the purpose of a ship canal, it must be free from all irregular currents. On the lower Elbe, near Brunsbuttel, where the canal empties directly into the North Sea, it was necessary that it should be closed by means of a lock on account of the great difference between flood and ebb, which varies in one tide from 9 ft. 10 in. to 27 ft. 6 in. In this way a waterway for the largest vessels can always be preserved in spite of the variation in the tide.

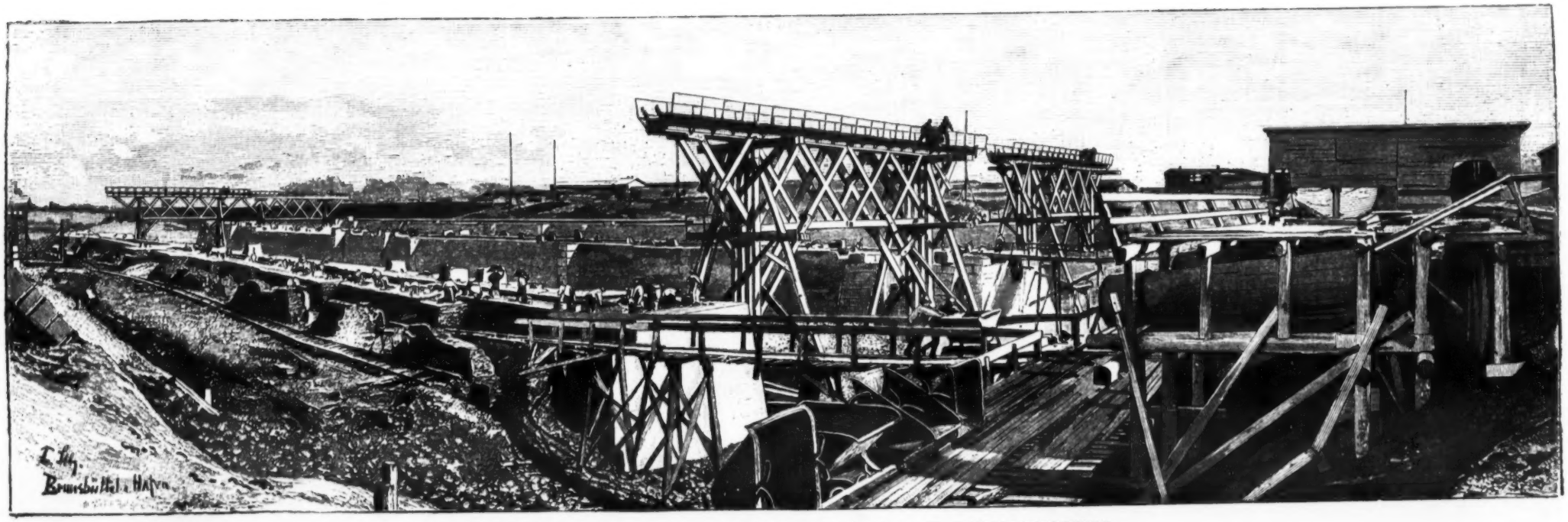
Each lock consists of two parallel contiguous chambers, each having an available length of 492 ft. and width of 82 ft. For the sake of comparison we would call attention to the fact that the largest German ironclads are 380 ft. long and 64 ft. wide, and the largest transatlantic steamers of the North German Lloyds 463 ft. long and 52 ft. wide. These dimensions give some idea of the magnitude of the work of building such locks, and two of our engravings show those at the ends of the Baltic-North Sea canal in course of construction. This was an immense undertaking, because of the difficulty in keeping the excavations dry, which was accomplished by special engineering. The excavations made for the chambers of the locks are 820 ft. long and 337,000 cubic yards of earth had to be removed for each. The masonry, consisting of the strong center and side walls, rests on a deep bed of cement, for the manufacture of which trass was prepared in special trass mills driven by steam. Blocks of sandstone are set in the angles and are adapted for the reception of strong gates. In spite of the scaffolding, temporary roads, etc., it is easy to get an idea of the plan of the masonry from our engraving, and by comparing the human figures with the walls about them it will be possible to comprehend the gigantic proportions of the work. The materials and the heavy parts of the structure are transported to the places where they are needed on movable frames and sliding platforms. Sta-



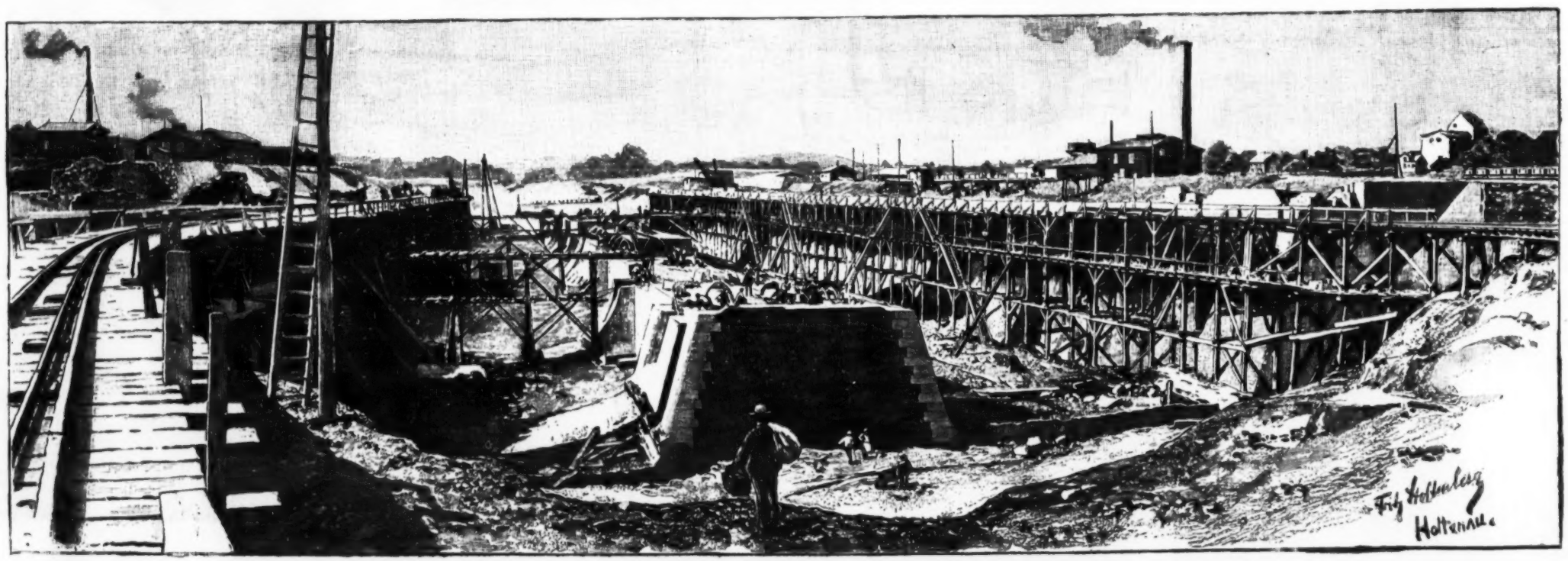
FLOATING ELEVATORS AT SCHULP, NEAR RENDSBURG.—DRAWN BY FRITZ STOLTENBERG.



THE BRIDGE OVER THE CANAL AT GRUNENTHAL.—DRAWN BY FRITZ STOLTENBERG.



BUILDING THE LOCK IN THE HARBOR AT BRUNSBUTTEL.



EXCAVATION FOR THE LOCK AT HOLTENAU.—DRAWN BY FRITZ STOLTENBERG.

tionary and portable engines of all kinds, cranes, pumps, windlasses, cars, heaps of brick and stone, tracks with rough rails and primitive switches, scaffolds extending high in the air, are all here in what seems a meaningless confusion, in which many hundreds of human beings are moving about and working singly or in groups, so that at first it is difficult for the uninitiated to understand what is being done. At night the place is lighted by numerous electric arc lights, for here at the ends of the canal the work must continue uninterrupted, so as to escape the danger of possible floods, from which it has been spared heretofore.

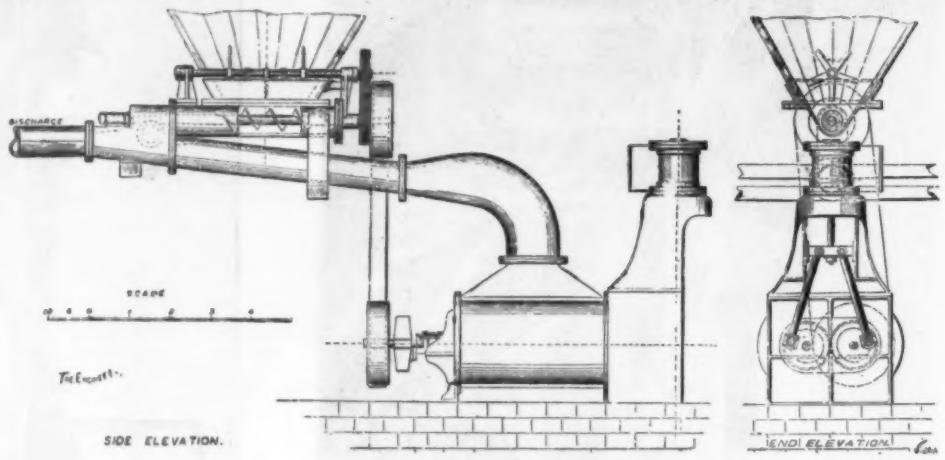
This canal, so important for German commerce as well as for war vessels, advances with certain step toward completion, thousands of workmen being kept busy day and night, and before many years have passed, the canal, with its great structures, which are such an honor to German skill and of which we have given a hasty sketch, will be ready for use.—*Illustrirte Zeitung.*

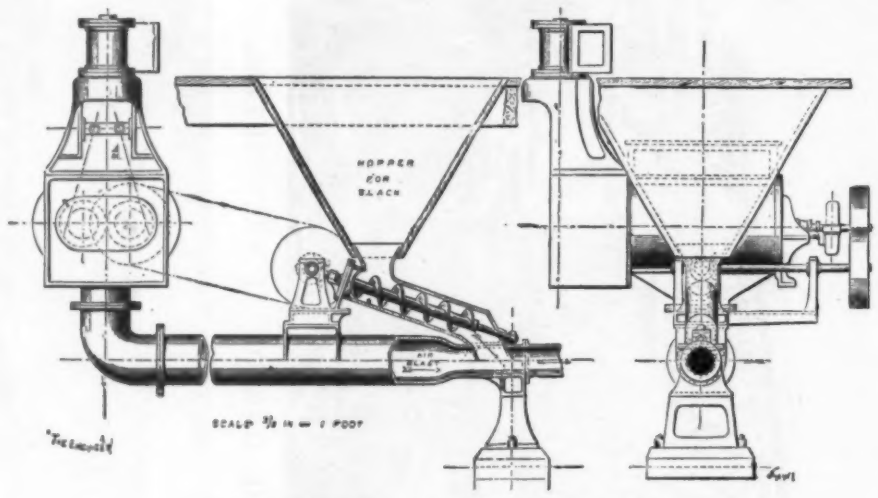
THE SWINGING BRIDGE OF TARENTO.

AMONG the great works of national defense inaugurated by the Italian government has been the fortification of Tarento and the establishment there of a naval depot. At a cost of five millions of dollars the works have been built, and the fort is now deemed to be almost impregnable. At the narrow entrance or canal from the outer harbor a huge swinging bridge has been erected, which is here illustrated from a sketch in *La Ilustracion Española*. The canal communicates with the external harbor and the internal anchorage known as the Mare Piccolo.

PNEUMATIC CONVEYOR PLANT.

IN several places in the United States small coal slack, and other such materials, are being conveyed considerable distances and with simple plant by means of an air current. We illustrate by the engravings two sets of the machinery employed as made in England by Messrs. Samuelson & Co., Banbury. It consists, says the *Engineer*, of a Roots blower arranged with a hopper for the material to be conveyed by a pipe, the end of which and its connection is also shown, the hopper being fitted with a feeder worm. From the hopper the material is moved into the conveying pipe by the inducted draught brought about by the blast in the latter. Our engraving shows the apparatus with sufficient clearness to make further description unnecessary, but it may be mentioned that it is used at a number of coal mines for moving slack, and takes the place of horses, trucks, and men. It is much more quickly and cleanly done, and the slack at the end of say 300 ft. may be raised to a large height for stacking. At the Edgerton Coal Company's Works, Jermyn, Pennsylvania, a set of the plant is placed near the small coal breaker, and conveys 350 tons per day of culm to a pile 300 feet away. The blower is 5 ft. 6 in. in length, runs at 75 revolutions per minute, the pipe 10 in. diameter, and rising about 110 ft. The culm seems to flow through the pipe without knocking at the walls, and it is said that plant costing £1,200 displaces labor that cost £3 4s. per day, and that it costs but 6s. per day for labor and oil. The cost of the steam power is not given, but in this case the engine employed has a pair of cylinders direct acting and 13 in. by 16 in. Against the cost of steam is set the cost by the old method of maintaining the tracks on a plain or on a dirt bank, the cost of ropes, mules, or dumpers. The delivery may be changed by simply turning the mouth of the pipe in the desired direction.

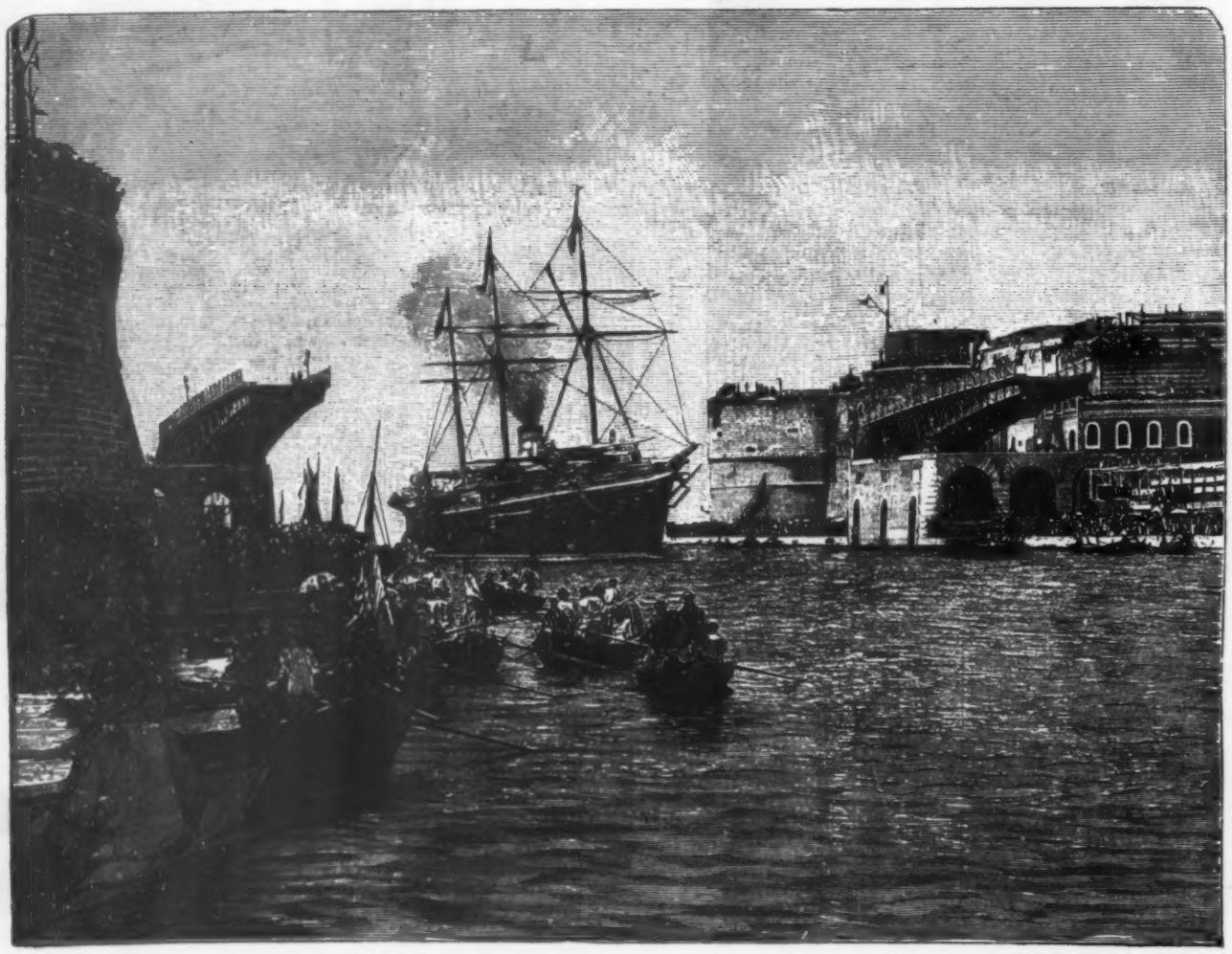




PNEUMATIC CONVEYOR PLANT.

HARGRAVE'S FLYING MACHINE.

WE have on several occasions noticed the flying machines constructed by Mr. Lawrence Hargrave, and described by him before the Royal Society of New South Wales. All these have been wonderful pieces of mechanism, combining lightness with rigidity in a marked degree, and each has been a distinct advance over its predecessors. The accompanying illustrations



THE GREAT SWINGING BRIDGE, ARSENAL OF TARENTO, ITALY.

show three of the more recent types. Fig. 1 shows the general appearance of these machines. A backbone carries two outstretched stationary wings or aeroplanes, which glide over the air, while in front are two flapping wings, which afford the propelling power. These wings are driven by an engine, whose motive fluid is compressed air, stored in the hollow backbone of the machine. The following are the principal dimensions:

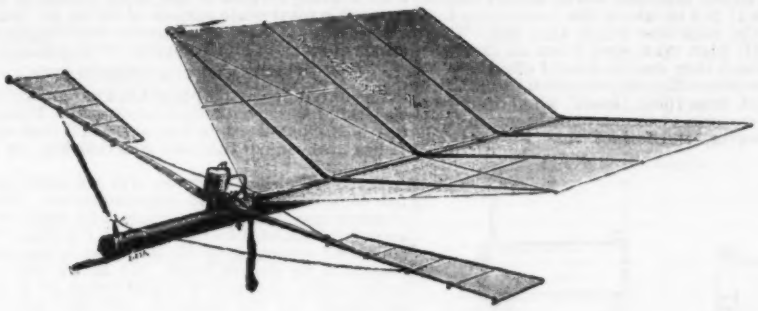


FIG. 1.

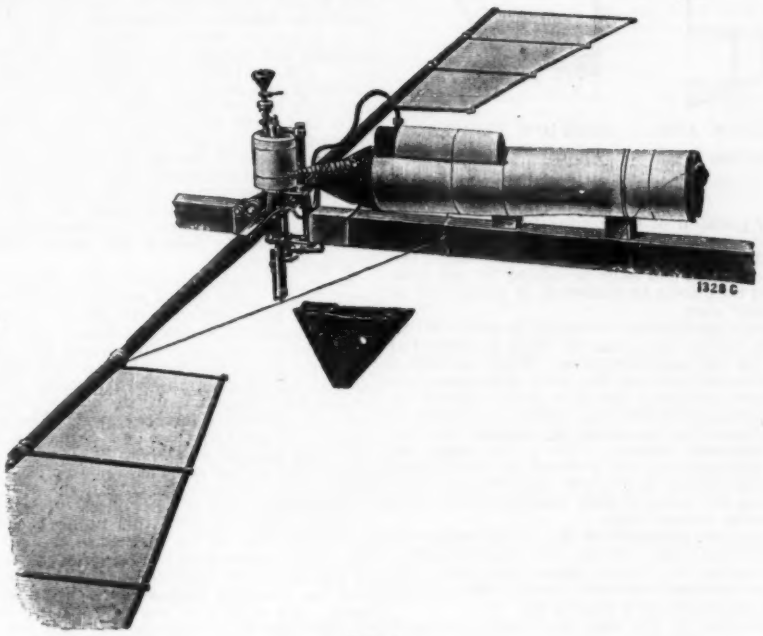


FIG. 3.

Pressure Container.

Volume	251 cub. in.
Length	6 ft. 11 in.
Diameter	2 in.
Weight	15¼ oz.
Working pressure	250 lb. per sq. in.

Motor.

Diameter of cylinder	2 in.
Stroke	1·28 in.
Reduced pressure	57 lb.
Weight of engine	11 oz.
Efficiency	0·29

Machine.

Length of wing	31 in.
Area of wings	216 sq. in.
Area of body plane	3074 sq. in.
Area in advance of the center of gravity	732 sq. in.
Total weight, charged	59 oz.

Five hundred and nine foot pounds of work produced 46 double vibrations, which drove the machine 512 feet.

Fig. 2 shows another form of engine, having a cylinder 2 in. in diameter by 1¼ in. stroke, and working at a pressure of 60 lb. per square inch. Its weight is 9 oz. The machine fitted with this engine on one occasion flew 343 feet in 23 seconds, with 54½ double vibrations of the engine. It was estimated that 742 foot pounds of work were done in driving the machine at 10·1 miles per hour.

The success which had been attained by the compressed air motors encouraged Mr. Hargrave to try steam. The conditions he laid down to be fulfilled were that the steam motor should be lighter than the compressed air apparatus, that it should have a uniform boiler pressure, and flap the wings of the standard size as fast as the compressed air engine and for a longer time. The Serpollet boiler was adopted, and as steel pipe could not be got in Sydney, copper pipe of ordinary trade sizes was procured. Many boilers were made and rejected; the one in the figure is a two-stranded coil, containing 12 feet of pipe, ¼ in. outside diameter, weighing 20¼ oz. with steam and water connections. Methylated spirit of wine was adopted as the fuel, and was stored in the small cylindrical reservoir shown in the figure. The boiler was inclosed in a cylinder of asbestos card, and the vaporized spirit mixed with air was spurted into the furnace. As much as 6·9 cubic inches of water have been evaporated by 1·7 cubic inches of spirit in 80 seconds, the engine making 182 double vibrations of the wings. The engine was of the usual type, with the addition of a feed pump, 5·2 m. in diameter, drawing out of the reservoir shown detached. The relation between the cylinder capacity and the boiler is:

Cylinder	2·2 cub. in.
Steam and water space of boiler	2·8 "
External surface of boiler	118 sq. in.
Internal " "	71 "

Chronograms showed that 1·66 double vibrations per second were made with 55 lb. pressure of steam, and 1·8 per second with 75 lb. A thrust diagram showed that:

2·2 vibrations per second produced thrust of			0·75 lb.
2·3	"	"	0·90 "
2·44	"	"	1·10 "
2·5	"	"	1·25 "

The total weight of the apparatus is 64·5 oz., which includes 12¾ oz. for the strut and body plane and 5 oz. for spirits and water. By aid of an ingenious indicator it was found that 0·169 horse power is developed when 2·35 double vibrations are made per second.

If the machine were loaded up with 10 oz. more spirit and water, it is calculated, from data obtained from previous machines, that it would have a possible range of 1,640 yards. On starting, the boiler is empty, and is warmed up by a Bunsen burner; then the spirit holder is heated till the flame ignites, the flame being maintained by a few shreds of asbestos put into the coil. When the flame is under way, part of the boiler gets red hot in a few seconds. Then the wings are moved up and down a few times by hand, squirting about a teaspoonful of water into the boiler, and then the engine starts.

Every one, says *Engineering*, must admire Mr. Hargrave's great skill as a mechanic, and the marvelous patience he brings to this subject of mechanical flight. If it had always been attacked in his spirit it would have escaped much ridicule, and greater progress would have been made. As it is, very great advance has been made during the last two or three years, since the matter has fallen into the hands of skilled mechanics, and further developments are to be looked for.

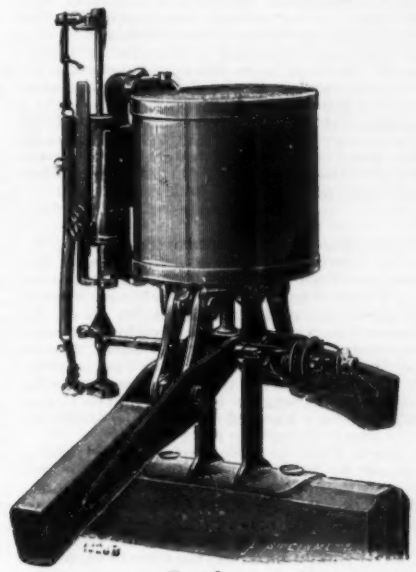


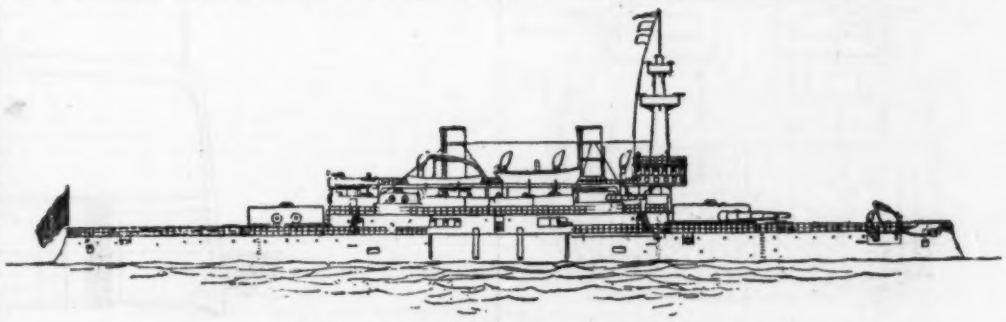
FIG. 2.

HARGRAVE'S FLYING MACHINES.

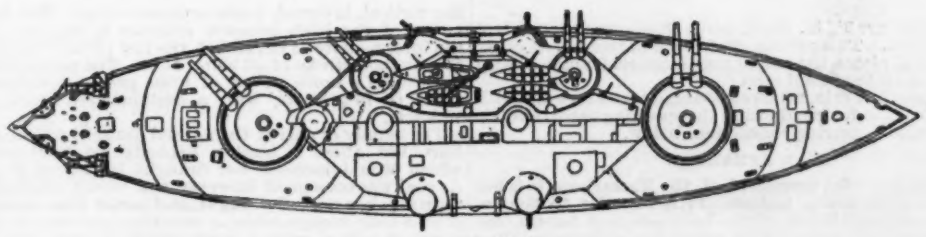
THE NEW BATTLE SHIP MASSACHUSETTS.

THE following interesting account of our new battle ship Massachusetts, recently launched, we find in the Boston *Herald:*

It may be remembered that an act of Congress, approved June 30, 1890, provided for the construction of three sea-going coast line battle ships. This was a wise piece of legislation, for up to that time the construction of vessels for the new navy had tended almost entirely in the direction of unarmored cruisers—vessels undoubtedly valuable, but not suited to bearing the brunt of a naval combat and meeting on fair terms the huge armorclads of foreign nations. For this latter purpose something more powerful was needed, and the importance was soon realized of adding to our fast-growing modern fleet ships of the required class. So fully did the Navy Department appreciate the importance of this move, and also the need for proceeding immediately with its execution, that the Bureaus of Construction and of Steam Engineering exerted every energy, and with such success that on July 1, 1890, the day after the approval of the act of Congress, the general plans were ready and the proposals to prospective builders issued. On October 1 following the bids were opened at the department. Four competitors appeared: The Union Iron Works, of San Francisco; William Cramp & Sons, of Philadelphia; the Risdon Iron Works, of San Francisco; and the Bath Iron Works, of Bath, Me. The contract for two of the ships was finally awarded to William Cramp & Sons, and that for the third to the Union Iron Works, of San Francisco, it being stipulated that the plans of the department should be subject to certain modifications at the hands of the builders. These modifications consisted essentially of lengthening the ships by 12 ft., involving an increase of displacement of about 1,200 tons over the 9,000 tons at first proposed, this increased displacement to be utilized by the department as it



THE BATTLE SHIP MASSACHUSETTS.



MAIN DECK PLAN.

saw fit. This virtually meant an addition of 1,200 tons to the carrying capacity of each ship.

The contract with the Cramps fixed the price of each ship built by them at $3,020,000 and that with the Union Iron Works at $3,180,000 for the vessel they constructed. These prices include hulls and machinery, but not the armaments, which are furnished by the government. The Cramp vessels were named the Massachusetts and the Indiana and the ship awarded to the San Francisco firm the Oregon.

THE HULL.

The hull of an iron or steel ship consists of two principal parts, (1) the frames and (2) the outside plating, the former being what are popularly termed the "ribs" of the ship. These two principal portions combine to form the great shell of the hull, which is, of course, stiffened and strengthened by innumerable beams, longitudinal girders, bulkheads, etc.

The hull of the Massachusetts is of steel, the stem, stern post, propeller struts, and rudder frame being heavy castings. The transverse frames (the "ribs") are placed 4 ft. apart in the double bottom and 3½ ft. at the ends of the ship, the double bottom not being continuous. Below the water line, the outside plating of the ship is about five-eighths of an inch thick, while above the water line it is seven-sixteenths of an inch thick. The vessel has a flat keel three-quarters of an inch thick.

There is a middle line bulkhead, well stiffened horizontally and vertically, between the two engine rooms and fire room on each side. There is also further extensive subdivision in water-tight compartments, by means of longitudinal and transverse bulkheads.

The entire structure of the hull is remarkably strong and well built, which is more than ever necessary in view of the heavy weights, in the shape of armor and armament, which the big ship will carry.

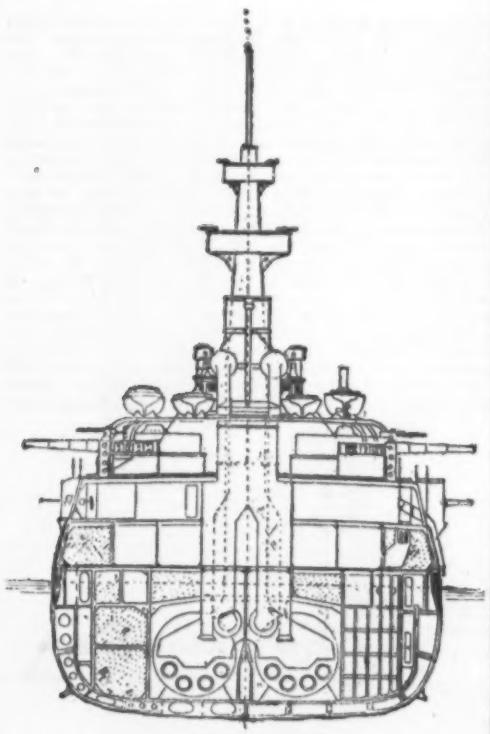
The Massachusetts is of the following principal dimensions: Length on load water line, 348 ft.; extreme breadth, 69 ft. 3 in.; mean normal draught, 24 ft. (same forward and aft); displacement, 10,200 tons; tons to increase draught one inch, 42.

ARMOR.

The hull is protected by belts of heavy armor 7½ ft. wide, turned in forward and aft to sweep around the bases of the armored redoubts at the bases of the heavy gun turrets. Forward and abaft this belt are heavy, underwater protective decks sloping down to 4½ ft. below the water line at the sides. Another armored deck extends across the ship above the belt. Above the belt, too, the sides are protected by 5 in. vertical steel armor. Coal bunkers are built over the belt deck, and water-excluding substance is placed on the slopes of the protective decks forward and aft. In addition, there is heavy armor protecting the guns.

The water line belt will be of Harveyized nickel steel—the finest armor in the world—18 in. thick, the redoubts rising at each end of it being 17 in. thick. These redoubts protect the bases of the turrets, the revolving gear, the loading apparatus, and other vital machinery, besides preventing a raking fire from forward and aft. It should be added that the 18 in. belt is backed by 6 in. of wood, two ¾ in. plates, and a 10 ft. belt of coal in the bunkers referred to above.

The protective decks forward of and abaft the water



MIDSHIP SECTION.
(Armor belt in black.)

line belt are 2¾ in. thick, while that over the belt is 3 in. thick. These decks are formed of two layers of ½ in. steel plates, the remaining thickness being made up of one plate of solid steel.

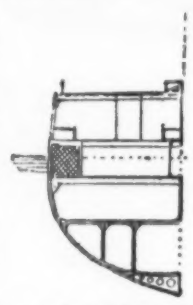
There is a 10 in. armored conning tower forward, with a 7 in. tube for conducting the speaking tubes, electric wires, and steering connections below.

ARMAMENT.

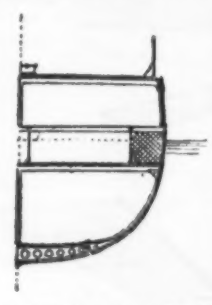
The powerful armament of the Massachusetts is her most conspicuous feature. It is superior to that of any, even the latest, of the battle ships of foreign navies; and not only of those afloat, but of those building or designed.

It consists of four 13 in., eight 8 in., and four 6 in. breech loading rifles; twenty six-pounder and four one-pounder rapid fire guns; four Gatling guns, and six torpedo tubes.

The 13 in. guns are mounted in pairs in two turrets, one forward and one aft, the bases of each being protected by the armored redoubts. The walls of these turrets are 17 in. thick, and they are at such a height that the guns are 17 ft. 8 in. above the load water line and 6 ft. above the deck over which they fire. They are thus sufficiently high up to give them an excellent platform, from which they may be fought effectively in any sea. They are also sufficiently elevated to minimize injury to the deck from their "blast" when fired over it. One the best features of the manner in which they are mounted, however, is the fact that they may be



HALF SECTION AFT.
Showing cellulose belt.



SECTION FORWARD.
Showing cellulose belt and floor plates.

loaded in any position of horizontal train. This is a distinct advantage, insuring unusual rapidity of firing, and possessed by few, if any, foreign battle ships, the largest guns of which can only be loaded in one position, to which they must be returned, at great loss of time, after every shot.

The 8 in. guns are likewise mounted in pairs in armored turrets, 8½ in. thick, one of which is located at each corner of the superstructure. They are 24 ft. 9 in. above the water, and can fire over the turrets on the deck below containing the 13 in. guns. The 8 in. guns, it is interesting to note, can pierce or shatter, at a distance of two miles, the armor of most of the modern foreign armored cruisers. They can open fire early in an engagement, on account of their great height above the water, and can be used with destructive effect upon the more lightly armored portions of the heavy hostile battle ships.

The 6 in. guns are mounted 14 ft. 10 in. above the water, on the main deck, within the superstructure. They are protected by 5 in. of armor, and have 2 in. steel splinter bulkheads worked around them, inside of which the ammunition is passed up.

Special attention, by the way, has been devoted to the means of supplying ammunition to the battery when in action, with a view of securing rapidity, certainty, and thorough protection of the service to the guns.

The smaller guns of the secondary battery are mounted in effective positions about the decks and in the fighting tops of the big military mast.

Of the six torpedo tubes, two are fixed in the bow and stern respectively, while the others are training tubes, placed two on each broadside.

The Massachusetts will also be provided with all the modern miscellaneous appliances for offense and defense. Among these will be torpedo nets, range finders, search lights, torpedo boats, etc.

THE MACHINERY

of the Massachusetts is adapted to propelling her ponderous hull. She has twin screws, the engine being of the vertical, inverted, triple expansion type. The diameter of the high pressure cylinder is 34½ in., of the intermediate 48 in., and of the low pressure 75 in., the common stroke of all being 42 in. The engines are to develop a horse power of 9,000 and a maximum speed of 16¼ knots, with a sustained sea speed of 15 knots.

The supply of coal at the normal draught will be 400 tons, but there is bunker capacity for 1,800 tons, which would increase her draught by about 33 in. As coal was consumed, however, she would gradually return to her normal draught, and could thus accomplish a long voyage without recoaling, arriving at the scene of action with a large supply of coal, and at fighting draught. The radius of action of 1,800 tons supply, at the ordinary cruising speed of 10 knots, is estimated at 16,000 nautical miles.

There are four double-ended boilers, each 18 ft. long and 15 ft. in diameter, and two single-ended donkey boilers, each 8½ ft. long and 10 ft. in diameter. All the boilers are of steel and of the horizontal return fire tubular type. Each boiler has eight furnaces, and the total heating surface of the main boilers is 17,460 sq. ft., with a total grate surface of 552 sq. ft. Each boiler and engine is placed in a separate water-tight compartment, in order to localize injury to any one of them.

SPEED AND COAL ENDURANCE.

The only apparently plausible line of adverse criticism that has been directed against the Massachusetts has been in regard to her speed and coal endurance. It has been urged that she was deficient in both respects.

These criticisms, however, will not stand after careful consideration of all circumstances. The Massachusetts was built for a coast line battle ship, more especially adapted to the work of repelling from our shores an attacking battle ship than to aggressive operations in far distant lands. As in all men of war, it is impossible to combine in one vessel of a given displacement all the desirable offensive and defensive features at their maxima, and, in view of the special service for which the Massachusetts was intended, it was wisely determined to emphasize the essentially important features of armament and protection. To do so it was necessary to sacrifice speed and coal endurance, but this was not done to an unreasonable extent. For the ordinary purposes of coast patrol, the sustained sea speed of 15 knots is probably ample, especially in view of the fact that, being near home posts and docks nearly all the time, the bottom of the Massachusetts would be kept in much better condition than those of hostile battle ships acting far from their bases, and she would thus, in practice, be apt at all times to develop her record speed, while her antagonists would, in all likelihood, fall off considerably from theirs. At any rate, very few foreign battle ships, indeed, exceed in service the speed designed for the Massachusetts.

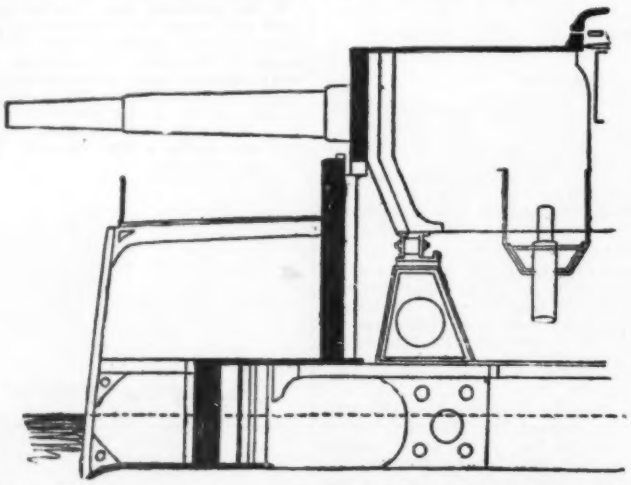
As for the coal endurance, the same fact of being near home ports would enable the Massachusetts to replenish her bunkers with great frequency, and, in case of necessity, as already stated, she has space on board for stowing nearly five times her normal supply.

On the whole, the fact remains that this great battle ship carries an unsurpassed armament and the best of protection. This is generally conceded even by jealous or hypercritical foreign experts. The Massachusetts need never run away, as she is actually a better fighter than any foreign war ship. The worst that can be said of her is that she would not be able to catch all those that sought to flee from her.

Her complement consists of 460 officers and men.

When one compares this number with the 800 or more that used to be carried in the old days by the big line of battle ships of a bygone era, some idea may be formed of the immense extent to which machinery and labor-saving devices have been adopted in the navy. All a man of war needs to-day is enough men to run her huge engines and fire her boilers, and enough on deck to fight the guns and supply ammunition. Not only are fewer guns now carried than formerly, but, although vastly larger, they require fewer men to handle them. There are no sail trimmers needed in action, no topmen, no light yard men. The "huge white-winged birds" of the past have been supplanted by the ponderous sailless masses of steel and machinery of the present.

The following items concerning the battery of the Massachusetts may be of interest: Each of her big 13 in. rifles is 40 ft. long, weighs 60½ tons, uses 550 pounds of powder as a firing charge, and fires a shell weighing 1,100 pounds. The muzzle velocity is 2,100 ft. per second, the muzzle energy 33,627 foot tons, and the corresponding penetration in wrought iron 30·1 in. The 8 in. guns are 35·4 ft. long, weigh 13·1 tons, and fire a 250 pound shell with a charge of 105 to 115 pounds of powder. The muzzle energy of the 8 in. rifle is 7,498 foot tons, and the penetration in wrought iron 18·1 in. The 6 in. guns are 18·8 ft. long, weigh 5·2 tons, fire a 100 pound shell with a 44 to 47 pound powder charge. They will penetrate over 13 in. of wrought iron at the muzzle.



SECTION THROUGH TURRET, SHOWING ARRANGEMENT OF ARMOR.

A single discharge from all the guns of both main and secondary batteries will emit 6,924 pounds, or more than 3 tons of steel.

COMPARISON WITH FOREIGN VESSELS.

Some idea of the manner in which the Massachusetts compares with the leading foreign first-class battle ships of recent date may be formed from an inspection of the following table, comprising the leading features of several representative battle ships:

DETAILS.	Massachusetts. (U. S.)	Royal Sovereign. (British.)	Centurion. (British.)	Massena. (French.)	Sicilia. (Italian.)	Brandenburg. (German.)	George Pobledonosets. (Russian.)
Date of launch	1892.	1891.	1891.	Building.	1891	1891	1891
Length on load line (ft.)	348	380	360	363½	400	354½	330
Extreme breadth (ft.)	69¼	75	70	65½	76¾	64	69
Mean draught (ft.)	24	27½	25½	26½	25½	24 7-12	26 7-12
Displacement (tons)	10,300	14,150	10,500	11,700	13,208	9,842	10,280
Maximum indicated horse power	9,000	13,000	13,000	11,000	19,500	9,500	15,000
Maximum speed (knots)	16¼	17½	18	18	18	16	16
Normal coal capacity (tons)	400	900	750	585	1,200	(?)	700
Radius of action at 10 knots (sea miles)	3,550	5,000	5,000 (?)	4,000	(?)	(?)	(?)
Maximum thickness of armor (inches) { Turrets	17	17	9	(?)	18	11¾	12
Maximum thickness of armor (inches) { Belt	18	18	12	17¾	4	15¾	16
Armament	4 13 in. B. L. R. 8 8 in. B. L. R. 4 6 in. B. L. R. 20 6 p'd'r R. F. 4 1 p'd'r R. F. 4 gatlings.	4 13½ in. B. L. R. 10 6 in. R. F. 25 small R. F. 8 machine guns.	4 10 in. B. L. R. 10 4·7 in. R. F. 8 6 p'd'r R. F. 9 3 p'd'r R. F. 7 machine guns.	2 11·8 in. B. L. R. 2 10¾ in. B. L. R. 8 5½ in. R. F. 4 20 p'd'r R. F. 4 9 p'd'r R. F. 12 3 p'd'r R. F. 10 machine guns.	4 13½ in. B.L. R. 8 6 in. B. L. R. 16 4·7 in. R. F. 27 small R. F. 2 machine guns.	6 11 in. B. L. R. 6 4 in. R. F. 8 3·4 in. R. F. A number of small rapid fire and machine guns.	6 12 in. B. L. R. 7 6 in. B. L. R. 8 4 in. R. F. 6 machine guns.
Torpedo tubes	6	7	7	4	5	7	7

From the above table, carefully recollecting the location, power, and other features of guns, it is at once evident that the Massachusetts is superior to all her rivals.

In armor, too, she is superior to all, not only in thickness, but in quality, that of the foreign ships being either plain steel or compound, while hers is of the unsurpassed Harveyized nickel steel.

The Bay State's namesake is, withal, a formidable craft, well worthy to support with credit the name she bears. Her design is unequaled, in the essential qualities of a fighting battle ship, by any foreign ship, and it may be of interest to know that the principal credit for designing her is due to Mr. Lewis Nixon, who was recently in Boston in connection with the trial of the cruiser New York. Mr. Nixon was formerly a naval constructor in the Navy Department, and while there he was intrusted with the weighty responsibility of designing the Massachusetts and her two powerful sisters. This he did, aided by the calculations of Naval Constructor D. W. Taylor, U.S.N., and both these gentlemen, although very young, deserve no greater monument to their professional knowledge and ability than the three big ships they designed. Mr. Nixon is now the chief naval architect of the William Cramp & Sons shipbuilding company, having resigned his commission in the navy to accept the position he now holds at a much higher salary than the government gives its employes, the Cramps having recognized in him a man of remarkable ability in spite of his youth. He is barely 32 years of age, having graduated from the United States Naval Academy in June, 1882, subsequent to which he underwent a post-graduate course of instruction in naval architecture at the Royal Naval College, Greenwich, England. He is now superintendent at Philadelphia of all the war ships now being built for the new navy by the Cramps.

SILICIOUS FIRE BRICKS.

THE plan which Mr. Joseph Khern, the Austrian metallurgist, has introduced for the manufacture of silicious fire bricks is an excellent one, and the material produced he describes as being much superior to any other refractory product obtainable in Austria.

The chief ingredient employed is quartz, which must be of the highest degree of purity, especial care and watchfulness being exercised to reject all such portions as show any admixture of iron or copper pyrites, carbonate of lime, or even mica, or felspar. This preparation is similar to that observed in the manufacture of Dinas and the silicious fire bricks made at Stolburg, near Aix.

The quartz, having been selected in the manner described, is heated in quantities of from 12 to 15 tons in a Rumford oven, or a continuous kiln, as for lime, may be used. At the end of 12 hours, having reached a full red heat, it is thrown into water; the best fragments are then selected and afterward cleaned by a simple jigging process, and then subsequently crushed under a tilt hammer until sufficiently fine to pass through a sieve having 60 holes to the square inch, which leaves the particles coarse and sharp.

Two varieties of fat clay are used to bind the coarsely pulverized quartz; the clays differ slightly in plasticity, and are very carefully prepared by thorough weathering, pulverization under light stamp heads, and fine grinding under edge rollers. A final sifting is performed through a very fine sieve of six hundred meshes to the square inch.

The tilt hammer used for pulverizing the quartz weighs 250 pounds, and is capable of crushing three and one half tons of the burned quartz in twelve hours.

In selecting the quartz, the purest quality is reserved for the first quality of bricks, which have to resist the greatest temperature and sudden changes; while the second and third classes of bricks are made for less exposed positions, and are composed chiefly of the remains of bricks which have been once used, and again pulverized and sifted afresh.

The following are the compounds employed for the different classes of bricks: First class, 16 parts of quartz to one of plastic clay, or 14 parts of quartz to one of leaner clay; second class, 16 parts of ground bricks of the first class to one of clay; third class, 8 parts of ground bricks of the second and third classes to one of clay.

The third class bricks are made more with an idea for their employment in portions of the furnace requiring greater mechanical strength than fire-resisting qualities. The materials are first mixed together in a dry condition, on a large, clean and tight platform of wood, and are then thrown into a tight wooden pugging-box, six feet square and nine inches deep. In this box the dry mixture should be about six inches deep, and be thoroughly incorporated by kneading with water and treading under men's feet, and occasionally turning over the mass with shovels, care being taken not to draw splinters from the wooden box into the clay. A sufficient quantity of water must be added to allow the mixture to be worked into a ball between the fingers without crumbling.

The second and third class bricks are formed in open moulds, the pug being beaten down by a metal rammer of about four and one-half pounds weight; the first class, however, are subject to a pressure of about three and one-half tons to the square inch during a period of three quarters of an hour before they are removed from the moulds.

The drying is done in chambers through which a current of air passes, at the ordinary temperature in summer, but artificially warmed in winter. The bricks are fit for burning in seven days. The kilns are rectangular chambers, each having two step-grate fireplaces in one of the shorter sides, and a flue communicating with a high chimney at the opposite end. The capacity is small, being only about 2,500 bricks. As soon as the kiln is filled the charging opening is partly closed, and a gentle fire is kept in the grates, the damper in the flue being closed.

At the end of 36 hours the charging hole is entirely closed, and the draught is stimulated by opening the damper in the flue inch by inch at intervals, until at the end of 72 hours the whole of the bricks have attained a strong white heat. The fires are then removed, the damper closed, the grates filled with sand, and cracks that may have been discovered in the kiln are carefully luted or smeared over with soft mud.

The charging opening should also receive careful attention and be faithfully daubed. After standing in this way for 36 hours, the charging place is gradually opened, and in 60 to 75 hours the burned bricks may be removed.

TRANSPARENT TOILET SOAPS.

THE best grades, as a rule, are made by what is called the "alcohol process," which consists in dissolving ordinary good, opaque soap, made from tallow, lard and other fats and oils, in boiling alcohol, and subsequently evaporating the solvent, leaving the soap in a more or less transparent condition. By this process, any carbonate of the alkali, sulphate of sodium, and other impurities present in the original soap, are entirely eliminated in the finished product, as these substances are insoluble in strong alcohol. In manufacturing transparent soaps, the solution of soap, which is first reduced to shavings and dried as completely as possible, is effected in a closed vessel, resembling a still, and when all of the soap has dissolved, the solution is placed in another still, from which the alcohol is distilled off and condensed, ready for further use, after which the residue of hot soap is withdrawn and placed in suitable frames to set. After cutting, the soap, which is usually muddy-looking and far from clear, is exposed for some time to warm air, to evaporate remaining traces of alcohol and of alcohol and water, during which time it becomes clear and transparent. By long keeping and exposure to air, the soap darkens in color, acquiring a rich amber tint. The addition of glycerin materially improves the soap by giving a more transparent product, besides imparting a pleasant, emollient feel in use. Sugar and rosin also have the property of increasing the transparency of soap. Various qualities of transparent soap are made by the alcohol process, resulting from the presence or absence of the above and other substances, and also from the substitution of methylated spirit for alcohol. A large amount of low-priced transparent soap is made by the so-called "cold process," from castor oil, tallow, cocoanut, palm and other oils. To make the soap, the fats and oils are melted at a low temperature (180° to 190° F.) in a jacketed pan, provided with revolving crutching arms or mixers, and the exact quantity of caustic soda solution of about 1·30 specific gravity required to completely saponify the oils is vigorously mixed in. The pan is then covered and left at rest for some time, during which the temperature rises considerably, and the saponification is supposed to be completed. A quantity of sugar dissolved in hot water is then stirred in the soap and some crystals of sodium carbonate also added. Alcohol is then put in to clear the liquid and cause the "fob" to rise to the surface, while the pan again remains covered and at rest for some time, after which the fob is skimmed, and the clear thin soap ladled into the frames, where the perfumes are added, and it is allowed to set. After two days it is cut into bars and tablet pieces, and the cakes stamped, packed, etc. It is a question whether these soaps can be advantageously made upon the small scale or not. Special apparatus and technical knowledge and experience are absolutely necessary in the production of a desirble article. We append several formulas which may be of service, the first one of which contains no glycerin and is made by the "cold process."

1. Cocoanut oil	35	parts.
Talc	10	parts.
Castor oil	5	parts.
Caustic soda lye, 37° B.	25	parts.
Caustic soda lye, 20° B.	15	parts.
Potash, 96 per cent	50	parts.
Sodium chloride	8	parts.
Calcium chloride	7	parts.
Boiling water	150	parts.

Dissolve the potash, salt, and calcium chloride in the hot water, and dilute the solution until it shows a dilution of 10 degrees B. Mix the oils, talc and lyes, and saponify by agitation. As soon as this occurs, mix the solution first made with constant stirring, and add perfume to taste. Pour the soap into forms and let it stand uncovered for one hour, then cover closely. For perfume, use 120 parts of oil of citronella, 80 parts oil of bergamot, and 10 parts of tincture of musk.

2. Here is a process which contains glycerin but uses no alcohol: 26 ounces of cocoanut oil, 30 of suet, and 37½ of castor oil are heated together, and allowed to reach finally a temperature of 156 degrees F.; to this mixture is then added 56 ounces of a 30 per cent. caustic soda solution at a temperature of 66 degrees F. When the mass has become quite stiff, it is heated in a water bath at a temperature of 180 degrees to 190 degrees F., until completely saponified and a clear transparent product results; 35 ounces of sugar and 3 of glycerin dissolved in 26 ounces of water, strained and warmed to 190 degrees F., is gradually stirred into the mixture; 10 ounces of freshly powdered sodium carbonate is then stirred into the mixture until it is thoroughly dissolved, when a sample of the resultant compound spread upon glass should become hard. The rest of the mixture is allowed to remain in the water bath for about two hours, when a sample cupful should remain firm, clear and transparent. This last can be insured, if necessary, by adding 1 to 2 ounces of sodium carbonate and warming the mixture to 145 degrees F. when cooled, to 135 degrees F. Several precautions are necessary in order to avoid the flocculent or turbid appearance of the product, namely, to use purified fats of the best quality, pure glycerin and water free from lime.

3. Best tallow	10	kilogrammes.
Best olive oil	2	"
Best cocoanut oil	4	"
Solution caustic soda, 38° B.	6½	"
Solution caustic potash, 38° B.	6½	"
Water (distilled)	1	"
Glycerin (C. P.) 28° B.	8	"
Alcohol	6¾	"
Water	1¼	"

Perfume with:

Oil bergamot	300	grammes
Oil geranium	50	"
Oil sandalwood	10	"
Oil Ceylon cinnamon	20	"
Oil cloves	20	"
Oil petit-grain (French)	50	"
Oil lavender	50	"
Alcohol, 94 per cent	600	"

Melt the fats and strain, heat to 75 degrees C., add the glycerin and the aqueous solution of the alkalies in a thin stream. Heat and stir until saponification takes place. Cool the mixture to 80 degrees C., then add the alcohol previously mixed with the water, this will redissolve the mass. Finally add the perfume, pour into moulds and let cool.

4. Animal fat	450 parts.
Cocoanut oil	50 parts.
Caustic soda, 36° B.	250 parts.
Common salt	100 parts.
Vaselin	150 parts.
Distilled water	1,000 parts.

Dissolve in the water bath, the fat and oil in the soda lye, add the salt and vaselin, and, finally, the water. Color and perfume to taste.—*Pharmaceutical Era.*

ENAMELING PAPERS.

THE following are a few methods for enameling paper to make it waterproof: 1st. Paraffin is melted in a large metal boiler, by heating with a fire or steam coil. When it is perfectly fluid the fire is withdrawn or steam shut off, and the mass cooled and stirred till it begins to solidify around the edges. Six parts of petroleum, ether, or bisulphide of carbon are added, and the mixture stirred till it becomes solid.

2d. The paraffin cake is cut into thin shavings with a knife, and placed in an airtight closed vessel. Five times its weight of bisulphide of carbon is then poured over it, and allowed to stand for three days or so, till it is completely dissolved. By this time the paraffin will be intimately combined with the bisulphide of carbon, forming a thick, milky mass.

The paraffin dissolved according to prescriptions Nos. 1 and 2 is added to the color as follows: 100 parts of *blanc fixe*, together with the necessary color to produce the desired shade, are mixed and thoroughly worked up with eleven to fifteen parts of gelatine (glue), previously soaked in water. From twelve to seventeen parts of dissolved paraffin and about twelve parts of softened wax, such as is usually employed in the manufacture of enameled papers, are then added. If the color mixture is too thick for covering, it is thinned down with a corresponding quantity of lukewarm water. It is passed through a fine hair sieve before it is ready for use.

3d. The paraffin can be added to the color without previously dissolving it in petroleum or bisulphide of carbon, in the following way: It is cut into thin shavings, mixed with the color paste, and the mixture

heated to 40° C., with continued stirring, till both are thoroughly and completely incorporated.

Of the above methods the first two are preferable to the third, as the solution of the paraffin is somewhat incomplete in the latter.

Papers enameled with the above mixture are washable, and are capable of being very highly glazed. The paraffin has no action on the colors, but the sulphureted hydrogen liberated on long contact of the bisulphide of carbon and glue has an influence on them. It is therefore recommended that the color mixture be used up as quickly as possible, because as soon as the color has been absorbed by the paper, and is dry, no chemical action takes place between its constituents. —*Kulhow's Review.*

A PORTRAIT OF COLUMBUS ATTRIBUTED TO TITIAN.

THE fourth centenary of the discovery of America and the opening of the Chicago Exhibition have particularly called the attention of the civilized world to Christopher Columbus. To tell the truth, the glory of the celebrated navigator, whose work, perhaps unconscious, has exerted so considerable an action in the history of humanity, has never undergone an eclipse; it is consecrated in all countries by monuments of all kinds. And yet, up to the present, Columbus has, perhaps, been the only one of all the great men of modern times of whom we possessed no absolutely authentic portrait. It is not that portraits of him, even old ones, were wanting, and the authenticity of which seemed out of doubt, as, for example, the one engraved at Rome in 1596, by Capriolo, that of Lorenzo Lotto, recently discovered at Venice, that of Come, from the collection of Paul Jove, that of the National Library of Madrid, that of the Municipality of Genoa, attributed to Jules Romain, that exhibited at Cogoleto, and, finally, the one that a descendant of Columbus, the Duke of Veragua, gave at the end of the last century to the Municipality of Havana. The iconography of the celebrated explorer would fill a bulky album. Almost all these portraits represent a man in the vigor of his age, beardless, and possessing something of the monachal. It is this type that has been reproduced *ad infinitum* by the painters of our age in a large number of historical pictures, and by all sculptors in the public edifices in Genoa, Barcelona, Philadelphia and New York, and recently in Naples, in the odd group by Pansilippe, representing Dante, Columbus and Giotto prostrate at the feet of Saint Francis. It is also the conventional figure modeled by the French sculptor Cordier.

However, this type of fat-cheeked canon with flat nose and black eyes does not at all respond to the testimony of Columbus' contemporaries, such as Oviedo, Ange Trivigiano, Las Casas, and especially his own son Fernando. So the biographer Harrisse is right in saying that all the portraits of the great navigator are works of fancy. The Columbus who is depicted to us in their writings by those who have shared in his adventures was a vigorous man, of tall stature, with blond beard and hair, clear complexion and blue eyes. This true Columbus would rather be the one who is sculptured upon the funereal bass relief of the cathedral of Havana, the one of the Museum of Vicenza, and of the portrait engraved by Mealla, painter to Charles III., for a history of the discovery of America, of which this king had ordered a compilation at Muñoz. It would be especially the original of the portrait that we now reproduce for the first time, and the history of which we shall briefly recount.

At the end of the fifteenth century, the Aldovrandi family was one of the principal ones of Bologna. Jean Francois Aldovrandi, the friend and host of Michael Angelo, began to form a gallery of paintings, which was carefully increased by his descendants, and certain *morceaux* of which have remained celebrated, such as the portrait of the naturalist Ulysses Aldovrandi, painted by Titian, at present in the Vienna Museum, and that of Doge Gritti by the same, now in the Vatican. In 1797, this gallery belonged to a Countess Aldovrandi, a good lady, having a horrible fear of the French, seeing in every soldier of General Bonaparte a Jacobin, a regicide, ready to massacre people and confiscate pictures. As soon as the French army approached Bologna, the Countess Aldovrandi tried to conceal her gallery. As the catalogue of it was printed, with the size of the canvases and a minute description of them, the owner had certain paintings curtailed and others enlarged laterally. Afterward she called in laborers, who, with coarse colors and black glue, went over the paintings, multiplying the draperies, converting knights into monks, cardinals into negroes and dressing short-robed nymphs in the latest style.

It may be conceived that the conquerors spared such horrors. Shortly afterward, at the time of the abolition of the majorats, the Aldovrandi family cleaned these paintings at hazard in order to sell them. As the gallery was extensive, the sales continued for nearly a century. Perhaps the collection is not yet exhausted. Two or three years ago, a Neapolitan antiquarian, Mr. Cannavina, purchased from the Aldovrandi heirs a male portrait, natural size, manifestly repainted, solely to see what there was beneath it. This antiquarian had heard of a superb Van Dyck thus purchased by one of his colleagues for the price of the frame. The picture having been carried to Naples, remained hanging for a long time in a corner of the store, where we have many a time seen it. One fine day, however, Mr. Cannavina decided to pass a sponge over the canvas. The glue, more than ninety years old, did not soften. However, it was found that it formed scales without much adhesion to the old painting. By means of a scraper that raised the crust, the work concealed by this strange color was gradually made to reappear in its integrity. From underneath the portrait of a bald-headed old man, clad in a long robe, came forth that of a man of about forty-five years, with a blond beard, with a buff doublet covered with a short Spanish mantle, the head covered with a fur cap, the neck surrounded with a voluminous white ruff that had been suppressed as attracting the eye too much. The left hand of the gentleman rests upon the hilt of his sword. The right hand rests upon a table covered with nautical instruments of copper. To the left we read a fragment of an inscription: OMBO S. D'A. In the upper right hand corner there is figured an escutcheon with the castles of Castille. At the feet of the individual is seated a small Havana spaniel.

The fortunate owner of this picture consulted a certain number of erudite Neapolitans, as well as our compatriot Viscount Alexander d'Agiout, a very perspicuous art critic. These gentlemen, despite the type, so different from that of tradition, thought it to be a portrait of Christopher Columbus. They went over the vast Columbian iconography, collecting everything that contemporaries have said about the features of the great navigator, and, in comparing the texts, became certain that they had indeed to deal with a portrait of Columbus, and that the abbreviated inscription was to be read: *Colombo Scovridor d'America.* We have already said that the type with the beard and the ruff is that of the bass relief of the Cathedral of Havana, of the painting of Vicenza and of the engraving of Mealla. The nautical instruments lying upon the table left no doubt as to the identity of the individual. The arms are indeed those given by Ferdinand of Castille to Cristopher Columbus. The Havana dog brought from the Antilles by the Spaniards—"a dog of mean breed and not barking," as the contemporaries say—seems to have been put there as a true certificate of origin. The inscription was perhaps put upon the painting fifteen years after it was finished. In fact, in the portrait, Columbus is about forty-five years of age. He is taken on the morrow of his first voyage, while the name America was not officially given to the West Indies until after the publication of Amerigo Vespucci's book in 1507. Let us add that one of the Neapolitan savants who have most occupied themselves with Columbus, Mgr. Cardinal Archbishop San Felice, does not contradict this identification.

By whom is the portrait? It is only necessary to

A PORTRAIT OF COLUMBUS ATTRIBUTED TO TITIAN.

inspect it to think of attributing it to Titian. None of those who have seen it has hesitated upon this point, and we perfectly remember having got this impression, even before the cleaning, when the face alone and the hands of the original were laid bare. We believe, with excellent judges, that it is an early work of Titian composed in the first years of the sixteenth century, either from nature or from a sketch of the time. The painter has evidently desired to rejuvenate his hero and fix his physiognomy for the future at the moment of triumph, before the deceptions and reverses that prematurely whitened the head and beard of Columbus, as his son Fernando testifies to.

It seems to us indisputable that this portrait really represents Columbus.—*L'Illustration.*

A NEW TELE-PHOTO LENS.

OUR attention has been specially drawn to a new lens of the "tele-photo" *genus* just received by Messrs. George Houghton & Sons, 99 High Holborn, W. C., and we have before us quite a number of views that have been taken by its agency. Having been afforded an opportunity of examining the lens in question, we are enabled to give the following description.

In the first place, there is what seems to us a well-made "rapid rectilinear," eight inches in focus, fitted with iris diaphragm, and which, when unscrewed and used alone, fits the flange, A, of the tele-photo system screwed on the camera front. This lens covers a half-plate to the corners, judging from a specimen of its work sent us. When screwed into the outer flange, C, of the tube (which is four inches long), carrying at its nearer end that which is next the camera, the tele-photo system is now complete. The image on the focusing screen is seen magnified up to eight times: but by operating a rack and pinion, the concave lens, B, can be brought nearer to or farther from the rectilinear lens in front, and can thereby be made to increase or diminish the telescopic effect to the desired extent.

In the views submitted to show its various powers, there is, first, a print from a negative by the rapid rectilinear alone, and this, we may say, leaves nothing to be desired as regards definition. We have next four other photographs, taken from exactly the same standpoint, showing degrees of enlargement, respectively three, four, five, and six times that of the primary picture. These, as they ascend in magnifying power, show a corresponding increase of detail, ornamental ironwork which is merely suggested by the original lens now showing its pattern with very desirable distinctness; while distant trees, still more feebly suggested in the primary picture, are shown individualized in the tele-photo ones.

An engraved scale on the sliding tube which is actuated by the rack and pinion permits one to see at a glance to what extent the camera has to be extended in order to produce the degree of magnification that is to be adopted in any special case, and this in our opinion is a great convenience.

The lenses, of Parisian make, are by the house of Clement & Gilmer (late Laverne), whose reputation is good. The concave lens, which acts such an important part in tele-photo combinations, is of the same diameter as those forming the rapid rectilinear. It is a crossed double concave, the deepest curve being to the front, the surface to the back being concave in only a slight degree. They are all said to be formed of Jena glass, and the price (5*l.* 5*s.*), which includes the rapid rectilinear, will be considered strictly moderate.

To magnify three times, the camera requires racking out six and a half inches; six times necessitates sixteen inches; and so on, according to the indications on the scale.

Messrs. Houghton & Sons supply the trade and the public in this country.—*Br. Jour.*

METOL.

WITHOUT committing one's self to the absolute statement that the last new developer is better than anything before it, it is, perhaps, possible to claim that it possesses good features that none of its predecessors do. I have tried most of, if not all, the modern introductions that have been intended to supplant pyro, but have not yet found the one that will, to my idea, do so. In metol I think we have the nearest approach to a developer possessing the same range and power as pyro, while it is undoubtedly free from the objectionable features of the latter, notably its dreadful staining proclivities.

It has, however, I think, one feature which will be considered by many a decided advantage over pyro, a feature which, although I am not a believer in "one-solution" developers, I cannot help recognizing as having its value. I refer to the power it gives of modifying the character of the image by simply varying its strength without altering the proportions of its constituents. This is a quality possessed to some extent by pyro, and indeed, more or less by all the newer candidates for favor; but in none, so far as my experience goes, is the range of power so great as in the case of metol. By varying the proportions of the stock solutions (where separate solutions are employed) as recommended in the formulæ issued with the metol, a great alteration can be made in the character of the image; but this is, of course, impossible where a one-solution developer is employed. In this case, however, if the stock solution be made of such a strength that, used alone or with a given proportion of water, it represents the highest degree of energy desirable, and with a given exposure renders the greatest softness, simple dilution with a further proportion of water will effect all that is necessary in the way of giving greater contrast.

As regards the necessity for the use of bromide, although I am always partial to a small addition even in commencing development, I think metol shows less absolute want of such addition than any other. For short or normal exposures, indeed, if the dish be well shaded during development, I can see little difference if the bromide be omitted from the solution until all the details are well out; at that stage, or where intensification begins, bromide is a necessity with every developer, but more especially with pyro. On one occasion, after mixing up a fresh stock solution of soda with hot water, I inadvertently applied the mixed developer in a quite lukewarm state, but the only effect was that the image appeared almost instantly and developed as rapidly as one on collodion. A strong addition of bromide, however, instantly checked it, and brought it within easy management.

Those who are not greatly enamored of one-solution developers are more likely to take to the system with metol than with any other, for, strange as it may appear, repeated use to the extent of three or four times, at any rate, does not seem to greatly alter its action; but a better plan than relying on the single solution, where economy is to be practiced, is to employ two separate developers, or one developer and one intensifier. Thus, say half a dozen plates are to be developed, I would set aside one portion of developer sufficient to cover the plate, with which to bring out the details of the picture, using it at its full energy. To another portion, in more dilute form, I should add a few drops of a ten per cent. solution of bromide, and use that as the intensifier, as it will continue to operate upon the image after the details are out without any further development.

This plan can be followed either with single or separate stock solutions, and if only half the work of finishing the negative be thrown upon each of the two working solutions, they will hold out very well for half a dozen developments, provided always the exposures have been sufficient. In my own way of working, I prefer to use a fresh quantity of solution for each plate, and this I apply at full strength—*i. e.*, the fullest working strength—until details are out, and then dilute it according to the appearance of the image, adding bromide as the action proceeds. The latter must be carefully used, as it is very powerful in stop-

ping the action of the solution on the finer details, and if added in excess will produce hardness.

The published formulas for use with metol are rather puzzling in their nature, but may be greatly simplified. I take it that for normal development from two to three grains of metol and about twenty grains of carbonate of soda to each ounce form suitable proportions. If a stock solution of metol containing six grains of that substance and a drachm of sulphite, and one of soda crystals containing two ounces to the pint, be used, they may be conveniently mixed to form any desirable combination. Let the stock solution be:

A.

Metol	120 grains.
Sulphite of soda	1200 grains.
Water	1 pint.

B.

Soda crystals	2 ounces.
Water	1 pint.

For normal development use equal parts, and add a little water if the subject is one that wants contrast. For under-exposure use more of A than B, and *vice versa*, bromide also being added in ten per cent. solution in the latter case.

A single-solution developer, where such is preferred, is made as follows:

Metol	120 grains.
Sulphite of soda	3 ounces.
Soda (crystals)	2 "
Bromide of potassium	10 grains.
Water	20 ounces.

One part of the above diluted with an equal volume of water forms the normal solution, more or less water being used in proportion to the length of exposure.—*W. B. Bolton, in Br. Jour. of Phot.*

NAU'S METHOD OF MAKING METAL PLATES.

By JOHN B. NAU, of New York City.

THIS invention has for its special purpose the manufacture of certain classes of metal plates, blocks or ingots, of whatever shape desired, that require different composition and different physical characteristics in different parts, as is the case with steel armor plate, for instance.

The author says: I introduce into the metal while molten in a suitable mould such element or elements, as, for instance, manganese, silicon, carbon, titanium, chromium, tungsten, etc., or any other element or elements that it may be desired to introduce in some special side or part of the metal and not in other parts. If, however, the entire mass of metal be liquid when these additions are made, some of the elements added would descend into lower regions or planes of the mass where they are not intended to be incorporated. To avoid this I propose that such lower regions shall be brought to a semi-solid, pasty, or solid condition, while the surface and upper portion of the mass is more liquid; that is to say, the bottom or distant surface may be solid and the adjacent metal semi-solid or pasty in different degrees, and as the upper surface is approached, the metal is liquid; or the bottom may be more or less pasty and the mass gradually more liquid as the top is approached; or the top may be semi-liquid and the mass become more solid as the bottom is approached. To obtain these results, means for cooling some parts of the metallic mass may be provided. By these means it will be possible to keep one part of the mould containing the metal at a lower temperature than other parts, by having it exposed to the air, or a forced current of air, or to water, steam, or any other cooling medium, in order to cool the metal or solidify it in that particular part or zone; whereas other regions or zones may be kept liquid longer, in order to obtain the desired effect above suggested. Thus, for instance, by cooling the bottom, and, if desired, other lower parts of the moulds by air or any other cooling medium, this region of the metal will be solidified, whereas the zone immediately above and in contact with the solidified portion will be pasty and the upper or top zone will be liquid. In this state it will be possible to increase the percentage of carbon or manganese or titanium or tungsten or silicon or chromium or any other element or elements that it is desired to have in larger proportions in the liquid regions by making the ordinary addition of, for instance, spiegel, ferro-manganese, ferro-silicon, ferro-phosphorus, ferro-titanium, or ferro-chromium, or any other substance or substances that when introduced either in liquid or solid or gaseous form will incorporate the desired element into the liquid portion of the mass. Of course by so doing the upper portion of the metal which has been kept in the most liquid state will absorb most of the elements introduced, whereas that portion of the metal that is partly liquid or more or less pasty, lying between the liquid and solidified metal, will receive less of that element or elements, and the solidified region will receive none of it. By this mode of operation, a gradual decrease of the percentage of the substance or substances that are introduced will be obtained from the most liquid to the solid regions. This gradual or uniform decrease of this element or elements will give a final piece, plate or ingot, the character of which will not be impaired by a sudden change in its composition in any zone or plane. The addition of these elements to a partly liquid, partly pasty, and partly solidified metal may be made to any previous compositions such as ordinary Bessemer steel, or open hearth steel, or crucible steel, or liquid soft iron, or to metal obtained by any method and of any previous composition or nature.

It must be distinctly understood that I do not claim as my invention the mere addition of any recarburizing element or any other substance to a mass of metal liquid or solid in order to incorporate some outside elements into the metal and to give the product to be obtained certain homogeneous qualities, as I am well aware that such additions have been and are daily made.

My invention on the contrary comprehends a process whose principal object is to obtain a product that is heterogeneous in its composition and physical characteristics, by the incorporation of other substances into certain defined zones of a metallic mass, which substances by their varying percentages in the different zones or parts of the metallic mass will impart to the metal different physical characteristics due to the different compositions in the different zones, these results being obtained by causing, through any suitable means, the metallic mass to solidify or become pasty in some regions, whereas still other regions are kept liquid while desired substances are incorporated into or added to the mass. The liquid or pasty surface of the metal may if desirable or necessary be covered by suitable materials, to prevent undesirable action due to the contact therewith of the heating flame or products of combustion.

I wish it to be distinctly understood that I do not limit myself as to the time at which I intend to make this addition to the metal. They can be made at any moment after the metal has been cast with its already ordinary addition, if such there be, and before that part of the metallic mass that is intended to receive the further addition has been left to solidify or become paste only. It can be made to metal which, after having been cast and even cooled down, is made by the application of any means to be liquefied again to any depth in that region where the addition is intended to be made or even is made to be liquid again, entirely by the use of any known means, and then made pasty or solidified again in one part, whereas that portion of metal where the addition is to be made will be kept liquid or pasty through whatever means may be deemed best suitable to obtain and maintain this pasty and liquid state. I also wish to state that the mould employed may be of any shape and form, and that the addition or additions to the metal therein may be made after having removed the upper part of the ingot, should it be found that this part presents a hollow space or is generally unsound, as is often the case. After the removal of such a part, the remainder would receive the addition, as has been described above.

To keep the upper part of the metal liquid, or even the whole mass, or even to liquefy already solidified metal, I do not limit myself as to the means to be used, these means being only an accessory to the process and only employed to obtain the desired results.

Fig. 1

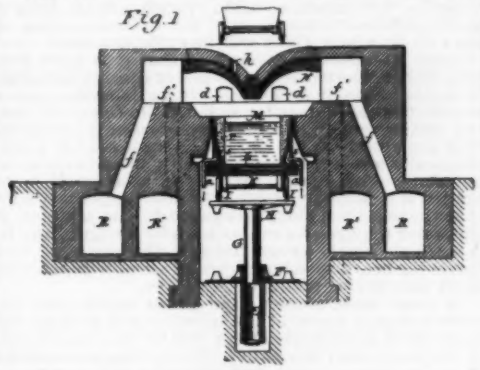
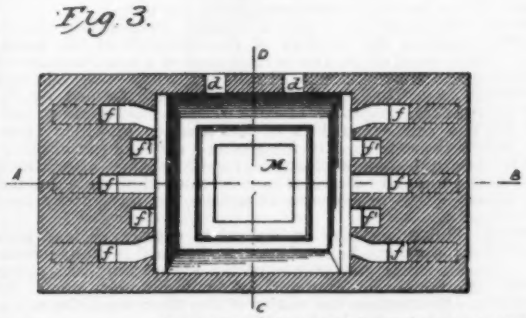


Fig. 3.



The whole mass of metal can be kept liquid for a certain length of time, or only a portion thereof, whereas the remainder can be left to solidify, or a once solidified and already cooled-down mass may be liquefied again entirely or partly by the application of any heat-creating means, such as solid, liquid or gaseous fuel, or electricity, either separately or collectively, or also one or more of these means combined together. I also wish to state that should it be considered desirable that the ingot or plate or metal block should contain certain elements and have certain characteristics on one side or end and other elements and other or different characteristics at the other end or side, for instance should it be desired to have tungsten or any other element or elements or compounds at one end or side and manganese or titanium or any other element or elements or compound at the other end or side, then the tungsten or any other element would be incorporated into the particular side or end while that side or end is still liquid or pasty or when already solid has been again made pasty or liquid through the application of any heat-giving appliance. After the incorporation of the desired element on this particular side, the manganese or titanium or any other element will be introduced into the other end or side of the plate which has been rendered pasty or liquid for that purpose after the first end or side has been solidified in its turn.

The furnace that I prefer to use to keep the upper part of the ingot liquid while the lower part is being solidified is a furnace similar to the one accompanying these specifications.

In the drawings, Fig. 1 represents a longitudinal vertical section on line, A; Fig. 2, a vertical cross section on line, C D; Fig. 3, a plan.

In the three figures similar letters represent similar parts.

E is a hydraulic cylinder located in the center of the foundation and supported by a cast iron plate, F, bolted to the foundation.

G is a hydraulic piston supporting a horizontal plateau, H, to which are fastened two rails, I. On these rails is run a car, K, mounted on four wheels. On the platform of the car rests the bottom, L, of the mould. This bottom is made of cast iron, and inside of it is located a coil of iron pipes to receive water for cooling purposes. The top of the bottom of the mould may be lined with refractory material if judged necessary. On this bottom rests the mould, M. This mould may be made of cast iron or wrought iron sheets bolted or riveted together. In the drawings the envelope is supposed to be made of wrought iron sheets. It presents at the lower end a double wall with a clear space between. This clear space is larger at the bottom and decreases to nothing at its upper end. On the drawings it is supposed to run to about the middle of the height of the mould. This space may be run, however, clear to the top of the mould between a double envelope. The purpose of the space is to cool the lower part of the ingot by a circulation of water or other medium in the space around the mould. The water may be introduced into the space by means of a pipe located at any point and run off in a similar manner. The coil in the bottom plate also receives its water through an inlet, *a*, and after having circulated through the coil, the water is run off through another aperture. As this entire construction has to be raised at will, the aperture, *a*, as well as the other apertures are connected with any water conduit by means of rubber pipes or flexible or telescoping metallic pipes. The mould has an inside refractory lining, *r*, thick at the top and reduced to almost nothing at the bottom. The thick part of the top will keep the heat a long time and consequently keep the metal in the mould liquid or semi-liquid at the top, while the lower thinner part of the refractory lining allows the ingot to be cooled and solidified in this region. The whole is placed in a reverberatory furnace, N, of the ordinary type or any other type. The Siemens type is shown here.

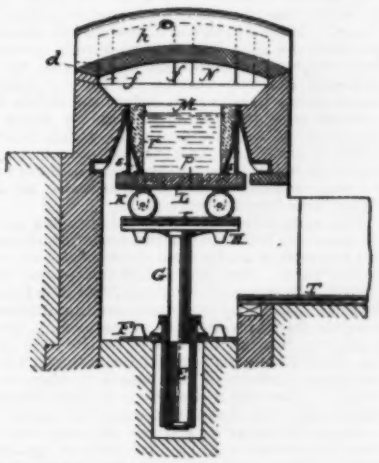
R and R' are the heat generators. R for gas, and R' for air. The flues, *f* and *f'*, carry the heated gas and air to the furnace on one side and lead it off on the other side.

d d are two doors on one side of the furnace and may be placed on both sides.

A is a hole placed in the roof of the furnace, through which the liquid metal is cast into the mould, M. Other holes may be placed in the roof above the mould, in order to measure, by plunging iron bars in the bath, how high the metal has been solidified.

T is a railroad track on which the truck runs, permitting the mould to be run into the furnace or taken away. When an operation is to be made, the piston,

Fig. 2.



G, is down in the cylinder, E, the car carrying the mould is pushed over the track, T, on top of the plateau, H, and then kept in place by whatever means may be used. Then the mould is raised to the position shown on the drawings. This mould is empty as yet. Heat is now applied to the furnace and the mould is heated inside by the reverberation of the flame to the right temperature, whereas both the bottom and the lower part of the mould are kept cooler by the circulating water. This cooling can also be begun immediately as just described, or sometimes after the metal has been cast into the mould. When the mould is sufficiently heated, the liquid steel is poured through the hole, *h*, while heat is still being applied. This heat is kept up in order to prevent the surface of the metal from solidifying. When the lower part has been solidified to a sufficient height, while the upper part is kept liquid or semi-liquid, the desired addition may be made either through one of the doors, *d*, by means of a run or through the hole, *h*. When the necessary reactions have taken place the heat is shut off in order to allow the metal to solidify to the top. To accelerate or maintain the complete and final solidification, the mould can be partly or entirely lowered, which action will bring it into a colder region. After complete solidification the car with mould and ingot is pulled out over the track, T. The ingot is stripped of its mould and is now ready to be transformed into the desired shape, either by rolling or hammering or hydraulic pressure or any other means. The so obtained product will now be ready to be hardened, either in water or oil, or by any other means whatever if it is found necessary to harden it. A steel plate treated by the above described method will constitute an article which not only will have a different composition in the different zones, but on account of the gradual change in its composition, its physical characteristics, such as hardness, or toughness, or malleability, etc., will also gradually change from one side to the opposite side, and whereas one side may be very hard and resistant, the opposite side can be left very soft and yet remain very tough. During the casting of the metal into the mould and dur-

ing its exposure to the heat in the furnace, the flame is preferred to be a reducing one, in order to prevent any oxidation of the metal. The metal being exposed during the whole operation to the reducing flame, can only be improved in quality.

Though this is a description of a special furnace, I wish to state that any other furnace may be used, as well as any other means adapted to carry out my invention, may be employed.

The pouring of liquid metal into an entirely heated up mould, exposed furthermore at its upper end to a very high temperature, whereas the lower end is made or allowed to cool down slowly and gradually from the lower regions toward the upper regions, has for effect that the metal will be kept liquid longest in the upper regions, and the last portion of the metal to be solidified will be the upper surface region. By so doing not only will it be made possible to introduce other elements into this particular region of the metallic mass, but the formation of blow holes, and especially the hollow space which is so often found at a small distance from the upper surface of otherwise sound ingots or blocks, will be completely avoided. A perfectly sound and dense block without honeycombed structure will be produced. Thus by this method a double end is obtained, viz.: (1) a sound metallic block without blow holes or hollow spaces at the upper end, and (2) the possibility by making further additions as hereinbefore described of obtaining the desired heterogeneous product.

THE "SAP" OF TREES AND ITS MOVEMENTS.*

By CHARLES R. BARNES, Professor of Botany, University of Wisconsin, Madison, Wis.

THE subject which I have chosen to present to you this evening is not chosen so much on account of the information which I am able to impart as for the purpose of correcting a great deal of misinformation which is widely prevalent. Many false ideas as to the nature and movements of what is popularly known as the sap of trees are extant, and in a large number of cases these ideas are founded upon mistaken notions of the physiology of plants.

Our own knowledge about many of these matters is yet exceedingly imperfect, and it is for that reason that many of my statements will, of necessity, be negative. The subject also is one which must have considerable interest for those who are so intimately engaged in cultivating fruit and shade trees as are the members of this society; and I take it that no fact in regard to the life and mode of working of the plants with which we are so constantly dealing will be entirely without interest.

It will be necessary for us at the outset to gain some accurate idea, if possible, of what is meant by the word "sap." If we think for a moment of its various uses, we shall see that it is a word which designates, not a fluid of definite composition, but one under which is included a great variety of watery solutions. The sugar maker begins even before the snows have left the ground to collect from wounds in the trunk of the maple trees a sweetish liquid which he calls "sap." After a considerable time the proportion of sugar which this liquid contains diminishes very greatly, and he then abandons his work because, as he says, the "sap" has become too poor.

The man who has postponed pruning his grape vines or trees to too late in the season finds that from the cut surfaces a watery substance is trickling which he calls "sap." But the sugar maker will be unable to obtain either sugar or sirup from this fluid, which is, however, called by the same name as that from which he manufactures his sweets. When a boy, who is making a whistle, hammers the bark of the twig in the spring, he finds it easy to separate the bark, because, as he says, the surface of the wood is then slippery with "sap." The sap of the boy is widely different from the sap of the pruner and the sap of the sugar maker.

Again, what we do not call sap may furnish us with some illustrations of the diversity of meanings of this term. We do not ordinarily speak of the "sap" of the apple, or of the "sap" of the grape, or of the "sap" of the orange, but call the fluids which these fruits contain "juice." And yet they are not more different in their composition from those fluids which we do call sap than the three examples already mentioned are different from each other. We might, therefore, in all reason, apply this word sap to the juices of fruits.

We popularly distinguish the older hard internal wood of the tree under the name of "heart wood," from the younger, softer, and lighter-colored external wood, which we call the "sap wood." To the fluids which saturate the sap wood we are constantly in the habit of applying the word "sap," but I have never heard it applied to the exactly similar fluids which saturate the heart wood. As far as the composition of these fluids is concerned, there is no reason why that in the heart wood should not equally well be designated as sap.

What then are we to understand by the word "sap"? Evidently not a substance of any definite composition; but the word signifies only in the most general way the various watery fluids which are found in the plant. There is no reason indeed why these solutions should not be called *water*, for in many cases they are almost as pure as the water which we drink. In the chemist's sense the water which we draw from our wells is a watery solution of various substances, and yet we do not designate it commonly by any other term than simply "water." In a similar manner it is quite proper for us, and perhaps it would conduce to clearness of ideas, to designate the watery solutions in plants simply by the term "water," understanding it in its popular and not in its strictly chemical sense.

Let us now turn to the consideration of the movements which the water in trees exhibits. I shall confine my remarks to trees simply for the reason that they present the greatest variety of water movement, and at the same time furnish the greatest difficulties in the explanation of these movements. If, therefore, we understand the movement of water in trees, we shall be able readily to transfer these ideas to the movement of water in the smaller plants, although the statements applicable to the trees are not always applicable to the smaller plants, because of their greater simplicity; however, the greater includes the less.

In the first place, there is need of a very considerable amount of water to supply the constant evaporation which is going on from the leaves of trees. Immense areas of delicate tissue are exposed to the dry air and oftentimes to the hot sun, in the form of foliage, and from this foliage there goes off at such times large quantities of water in the form of vapor. The water needed to supply this evaporation must come from the soil, because it is not possible for the leaves to take in any water, not even when they are wet by the rains or by the dews. The water enters, not at the base of the trunk where the large roots are found, but only at the extremities of the finest rootlets. At these points the rootlets are clothed with a "nap" or "pile" of fine hairs.

These root hairs must not be confounded with the fine branches of the root, for it is only the finest branches which are covered with the close-set hairs. Consequently, it is only the youngest and most delicate parts of the root which allow the entrance of the water. But the water escapes from the leaves, and from the point of entrance to the point of exit is a far cry for the coursing droplets. How does it pass through this long space?

It is just here that our knowledge is most defective. We know a number of things that are true in regard to it, and we know a number of things which are not true in regard to it.

We know that it moves in the sap wood of the tree, and neither in the bark nor in the heart wood. Many of you must have made observations which are sufficient to establish this point. You have, for instance, observed that the bark of trees might be peeled off for a considerable distance, and that the leaves would still retain their green color and their freshness. In many cases, indeed, the mere removal of the bark from the tree is not sufficient to bring about its death until several months, and in some trees not until several years, after the injury. Death, however, is inevitable sooner or later; but the fact that the leaves remain fresh for so long a time is evidence that the supply of water is not interfered with. Death ensues from a totally different cause, namely, from the starvation of the root, in a way which will be explained later.

Again, you must have observed that it is quite possible to have the entire heart wood of the tree removed, as is often done by decay, and yet to have the leaves remain fresh and green for an indefinite time. In fact, the rotting out of the heart wood scarcely interferes with the vitality of the tree, except as it renders it mechanically weaker, and consequently more liable to be overthrown by storms. If any further proof were needed it is perfectly possible to show experimentally that the sap wood alone is engaged in the transfer of the water required for evaporation by cutting into it. A saw cut which passes through the sap wood, but leaves the heart wood intact, brings about within a very short time the withering of the leaves.

In some trees, indeed, a cut which severs only the outer youngest layers of the sap wood will produce the same effect, since in such trees *only* the youngest layers of the wood carry the water. By experiments on twigs it can be demonstrated that withering will occur even if the bark is almost completely uninjured.

We know the water to supply evaporation moves chiefly in the cavities of the elements of the wood. The wood of the tree is composed of a large number of *fibers*, that is, elongated cells pointed at both ends, and of *ducts*, that is, tubes of great length formed by the breaking together of rows of cells placed end to end. You can get an idea of the manner in which these ducts are formed by imagining a series of round pasteboard boxes piled one on top of another, after which the top and bottom of each is removed, so that, instead of a series of separate chambers, we have now a long tube.

The fibers may be likened to a series of lead pencils, sharpened at each end, and placed in contact with each other, the points of the lower ones overlapping the next ones above and fitting in between them. In my illustration the cavity of the fiber would be represented by the lead, and it would be more accurate if we could conceive of the cavity as not extending entirely through the pencil, but stopping short of the point. Minute pits extend from the cavity in one of these fibers to the other, and the walls also of the long ducts are also marked by larger thin spots. It is in the cavities of these ducts and fibers that the water chiefly travels.

We do not know what part is taken in this ascent of the water by those peculiar elements of the wood which you know by the name of silver grain or the pith rays. You will remember these as the shining plates of tissue which extend from the center of the wood toward the circumference. They are particularly prominent in the oak and show most when it is split "with the grain." It is probable that these cells have a great deal to do with the movement of water, but their exact *role* is not fully agreed upon.

We are in almost total ignorance at the present time as to the force by which the water is elevated through so many feet. There are trees in the gullies of Victoria, Australia, whose height exceeds 470 feet, and we must invoke some force which is able to raise water from the level of the soil to the level of the highest leaf. A year ago we thought we had a hypothesis which would account for this movement, but later researches have brought to light some facts which are at present totally irreconcilable with what was a most charming, and at that time, a most satisfactory explanation, and we shall be obliged to abandon it unless the wine of the new knowledge can be held by the old bottles of theory.

At the time when our knowledge of capillarity was greatly extended by the celebrated researches of Jamin it was thought that we had knowledge of a force adequate to account for the raising of water to these great heights. The fibers and ducts which I have described to you seemed to answer very perfectly the requirements of capillary attraction, and it was thought that this force, by reason of which water rises through narrow spaces, was the one sought. But the rise of water in capillary spaces is proportioned to the size of the opening; the smaller the opening, the higher will it rise. With the decrease of the caliber of the tubes, however, the friction increases enormously, and only small quantities will be able to be moved on account of the diminished size of the tubes. It was quickly seen that, in order to account for a rise of even a hundred feet, the tubes of the wood must be vastly smaller than they really are.

When it was found that the air in a plant is under a less pressure than that outside the plant, it was thought that the force had been discovered, and that atmospheric pressure furnished the explanation. Negative pressure, however, on the interior never reaches zero, and consequently cannot account for a rise of more than 33 feet.

Again, what was called root pressure was invoked to explain the phenomena. It is found that water is absorbed at certain times so rapidly by the roots that it exists in the plant under considerable pressure, and it has been claimed that root pressure, combined with the other forces already known, was adequate to account for the rise of water. But this, too, has failed us.

It is, perhaps, the greatest weakness of the last theory (that of Godlewski), which we have just had to abandon temporarily at least, that it depended for its explanation upon the indefinite and illusive "vitality" of certain portions of the plant. Godlewski's brilliant hypothesis, which ascribes to the activity of the living cells of the medullary rays the function of receiving from lower levels the water and passing it on to higher tissues through rhythmic variations in their osmotic power, due possibly to respiratory changes, may yet hold the clew which we are seeking. But when Strasburger jacketed a young tree for a distance of 35 feet, and kept it surrounded by hot water until all of the living cells in the tree trunk were unquestionably killed, and when under these circumstances the water supply to the leaves was not interfered with, so that they remained green and fresh, we were obliged to conclude that the lifting of the water is not dependent upon the life of the tissues directly, but that it is evidently carried on by a physical process yet to be explained.

Before passing from this topic of the movement of water which supplies evaporation, I must allude to a very common and widespread idea—at least I judge it to be widespread, because it is so frequently propounded by my students—that "the sap goes down in winter and up in the spring." Just where the sap is supposed to go in winter is not exactly clear; since, if the roots are absorbing water in the fall when the evaporation is diminished, they are likely to have quite as much water as they can hold already. The conception, apparently, is that all of the water lodged in the trunk and spreading branches goes downward into these roots.

It needs, however, only the most casual examination of trees in winter to discover that at this time they are almost saturated with water. The twigs of the hickory tree, for example, will be frozen on a cold day in winter, so that they are as brittle almost as glass, and one can snap off a twig half an inch in diameter as though it were an icicle. The same twig, when not frozen, on a mild day will be so tough that there will be no possibility of breaking it.

Again, if one cuts off a branch from a tree in winter and brings it into a warm room, he will quickly discover that water is oozing from the cut end, showing that the twigs are almost saturated with it. As a matter of fact, the water in trees increases from midsummer or early fall to the beginning of growth in early spring. There is thus no necessity for any "going up" of the sap in spring until the leaves are expanded and the water with which the tree is already saturated begins to be evaporated from the foliage.

A second movement of water in trees is that which occurs in the so-called "bleeding." The bleeding of trees occurs at different times of the year, either before growth has begun at all or just as it is beginning. In the two cases the cause is quite different. We find a good example of both sorts of bleeding in the gathering of the sap by the sugar maker. This gathering begins at the time when the ground is still frozen and the roots are almost or quite unable to absorb any water, but at a time when the air is warmed through the middle of the day by the increased heat of the sun. At first the expulsion of water from wounds made in the trunk is due to the expansion by heat of the air inside the smaller branches and twigs of the tree. This sets up at once a pressure upon the water, and this pressure is transmitted to all parts of the tree. The water with which the tree is filled is thereby forced out as soon as an opening is made for its escape.

Later in the season, however, the roots begin their work of absorption, and there is then set up the so-called *root pressure*, by reason of which the water is forced out at the same openings. The latter sort of bleeding is necessarily delayed until growth is about to begin, and is checked as soon as the foliage is sufficiently expanded to begin evaporation.

A bleeding similar to the last takes place at the hood-like tips of grass leaves, where the skin is nearly always ruptured. The little drops of water which accumulate here are commonly mistaken for dew, but are merely droplets exuded from the interior of the leaf, because the falling temperature of the air toward evening has diminished the evaporation from the leaves, while the roots in the warm soil are still absorbing water, and consequently producing an internal pressure. The movement of water in these cases of bleeding, it will be seen, is necessarily toward the point of exit, which may be above or below the point at which the pressure arises.

A third sort of movement of water is that which takes place in the nectaries of flowers and leaves. The flowers of our common linden, for example, secrete a considerable quantity of sweet fluid, which is sometimes miscalled "honey," but is properly known as nectar. Honey, by the way, is nectar after it has been digested by the bees. At certain points in the flower there are groups of cells whose special business it is to withdraw water from the parts below, and filter it through their outer walls, after having added to it the materials which make it sweet. The movement of water in this case is extremely limited.

The last movement of water of which I shall speak is of those solutions which contain the food of the plant. These materials are not those absorbed from the soil, or gathered directly from the air, but they are the substances which have been manufactured by the leaves out of the materials obtained from the soil and from the air. Since these foods are put together in the leaves, neces-

* An address delivered before the State Horticultural Society of Wisconsin, February, 1893.—*Science.*

sarily the movement of water containing them in solution must be in a different direction from that which supplies the evaporation. The materials thus manufactured in the leaves must be carried either to those parts which are growing or to those places in which they are to be stored for future use. It is manifest at the first glance, therefore, that the direction of the movement must be in general *inward* from the leaves, and, since the roots require for their nutrition a considerable amount of these substances, there must be a very decided *downward* movement to supply them.

Now it is plain that these solutions of food must keep out of the way of those portions of the water which are chiefly to supply the evaporation from the leaves. We have seen that the latter travel in the sap wood. The food currents, however, travel almost exclusively in the inner parts of the bark. You will therefore understand why stripping off the bark, or even cutting it, insures the death of the tree eventually, even though the leaves remain long unwithered. Since the roots depend upon the food formed by the leaves, they perish when severed from their base of supplies.

The movement of the evaporation stream is relatively rapid. The movement of this food current is relatively slow. We do know something of the mode of movement of these food currents. They are apparently brought about through the process known as diffusion, or osmosis, and are therefore necessarily slow. The cause of the movement is practically the same as that for the movement of oil in the lamp wick, although it is by no means by the same method. The oil in the lamp wick travels upward because at the top it is being destroyed *as oil* by reason of the heat of the flame. So the direction and existence of the current of water carrying food is because the various substances dissolved in the water are being altered at the place of growth or storage into new materials. The commonest of these food substances is sugar, and at the growing point of the stem, for example, the sugar is being constantly destroyed as sugar and is being converted into cellulose or protoplasm or some other material. So long as that alteration is going on, just so long will the sugar particles move toward that point.

But I must not impose further upon your patience. I have tried to sketch very briefly, and only in outline, the different movements which the water in the plant is undergoing. I have said nothing of the extreme variety of materials which may be found in this water in different plants, or even the variety found in the same plant at different times, but have endeavored merely to show you that there is going on constantly in the living tree a series of molecular and mass movements, of which too few people have any conception. To our imperfect knowledge let me hope that some of you may contribute facts which shall enable us some day to explain the many things which are now obscure.

EXTREMES IN THE VEGETABLE KINGDOM.

THE more we become acquainted with the resources of Nature as they are displayed in the vegetable kingdom, we cannot fail to be deeply impressed with the far-reaching extremes that are made to illustrate plant life in its multifold growths and forms. In the division *Phænerogamia* (flowering plants) we see a marvelous variety in range, abundance and characteristics. But it is in the *Cryptogamia* division (flowerless plants) where the great extremes are found.

As to temperature, many of the Arctic lichens are said to vegetate below the freezing point. In the Algæ class, the red snow, so called (of the simplest forms of plants; species with but a single cell), makes its home in the Arctic regions, where in large masses together it is seen reddening the snow sometimes for miles in extent. The wonderful family, the Diatoms, whose minute forms are diffused so extensively over the earth's surface, in some cases have a frigid home. Dr. Hooker has informed us that not only the waters but even the ice of the Antarctic ocean teem with them. Having noticed the minimum toward which certain plants may thrive, let us turn attention to those approaching the maximum of temperature. Among the Algæ, some of the confervas are found growing in hot springs where the water is at boiling heat. Species of chara are sometimes seen growing in these hot springs. Quoting from Sir J. Staunton: "At the Island of Amsterdam a spring was found, the mud of which, far hotter than boiling water, gave birth to a species of liverwort."

Light may be regarded as an important element in vegetable growth. Many of the mosses and lichens flourish on rocks and old timber fully exposed to the sun. On the other hand, there are species of fungi whose homes are in dark caverns and mines. At this point let us note an extreme as to both light and air; striking illustrations of which are the truffle and the curious tuckahoe, only found enveloped in the soil a few inches below the surface.

Moisture is an important requisite in plant life. But as diverse examples, we are aware of the large number of aquatic plants, with special mention to the seaweed fathoms deep in the ocean; while some of the lichens are at home on the bare rocks. However, every plant, from the highest to the lowest, needs probably at some stage of its growth some degree of moisture, either from the atmosphere or surrounding elements.

After this brief survey of the widespread diffusion of vegetation, let us consider some of the striking characteristics of plants; first, as to age and growth. A quotation from "The Universe," by Pouchet, is here in place. "Some of our common moulds pass in one day through all the phases of life. This lapse of time is sufficient for them to appear in, fructify and die. But by a singular contradistinction, some plants of the same class only grow with inexplicable slowness. One of those lichens which show like plates of golden yellow on the roofs of our houses, was watched for forty years by Vaucher, without his seeing that it increased to a perceptible extent. Accordingly De Candolle said that the lichens which cover our rocks possibly go back to the times of the cataclysms which laid them bare."

What vast contrasts are presented in the form and size of plants! Beginning with organisms so small as to be seen only through a powerful microscope; passing on through the series and gradations, going beyond even our majestic forest trees, we come to the enormous seaweeds, often forming immense beds, their branches and leaves spread over large portions of the ocean. Some specimens are reported more than a thousand feet long. One species (*Marcrocystis pyrifera*) has been known to attain a length of more than fifteen hundred feet.

In the germination and reproduction of plants we find marked illustrations of Nature's extreme methods. The Algæ class furnishes species of but a single cell. Some of the fungi, however, contain millions on millions of cells. According to Worthington G. Smith: "The cells in a large mushroom, weighing four and a half pounds, were found to number 106,596,000,000,000. So extremely light are these cells that in one species of fungus it takes 1,624,320,000,000 to weigh an ounce troy. Each of these cells is furnished with a coat or cell wall, and contains within itself protoplasm, water and other materials."

As to vitality, many of the short-lived plants die immediately after being removed from their peculiar habitats. Some of the delicate ferns droop and wither in a few minutes after being taken from the earth, while other species of the same class do not lose their vitality for years in the herbarium. Some seeds require to be sown soon after they begin to mature. On the other hand, the stylospores of the fungus *Pestalozzia*, preserved in the herbarium for more than half a century, have germinated as readily as the stylospores taken from a fresh plant on the same day.

G. C. NEALLEY.

DANDELIONS AS WEEDS.

CAN you suggest some mode of eradicating dandelions from lawns? In this neighborhood they rapidly increase from year to year. On a large lawn the myriads cannot be dug up one by one, and to prevent their going to seed by frequent use of the lawn mower is a herculean task. Is there any other remedy that you know?—*H. T., Tenafly, N. J.* [Whenever a piece of land is converted into a lawn one must either take the growth already upon it in a greater or less degree, or else convert the whole surface temporarily into a summer fallow, for the purpose of bringing all the foul seeds to the surface and thus destroying them. It sometimes happens that running the lawn mower once a week will prevent the formation of seeds and thus eradicate them, provided they are annual or biennial. But if perennial, like the dandelion and plantain, the remedy cannot succeed unless in connection with smothering their growth. Strong lawn grasses may

be sometimes given possession by first top-dressing freely with fine compost, which may result in crowding out the weeds. These remarks apply chiefly to large lawns, which it is desired to treat wholesale. In small lawns the intruders must be treated with hand labor. One of the easiest modes is touching the crown of every plant with a drop or two of sulphuric acid. A convenient apparatus for this purpose is represented in the accompanying figure, where the acid is held in a large-mouthed bottle carried by a wire handle and reached by the straight rod which rests within it. A single touch by this rod with the acid finishes the work. An active person with a quick eye will go over many in a day, but he must take special pains not to tread where he has deposited the fresh acid, or his shoes will soon be eaten with holes. A small spud will throw them out freely in wet weather.]—*Country Gentleman.*

CALIFORNIA RAISIN GRAPES.

LEADING California growers are experimenting with seedling raisin grapes, and, although they vary greatly, some seedlings of promise are already beginning to bear. A larger seedless grape is desirable and is quite likely to be obtained. There are now two types of the Muscat grape grown for raisins in California. The type preferred in southern California is the true Muscat of Alexandria; this is the variety most esteemed for this purpose in Valencia and Smyrna. The large, firm berry is egg-shaped, smaller at the stem-end, and when cured and packed this Muscat looks a little smaller than Muscatels of the same grade. The Muscatel, or Gordo Blanco grape, while similar in general appearance to the Muscat of Alexandria, is distinct in habit of growth, style of cluster and form of fruit. The vine spreads, but more evenly, without the upright cane so often seen in the Muscat; the clusters are more compact and the berry is rounder, being a short oval. This is more nearly the type of the best raisin grapes of the Malaga district, and is the favorite raisin grape of the San Joaquin Valley. A third type of the Muscat class, though not yet grown to any extent, is the Huasco, of Chile. This is said to be a seedling of the Muscat of Alexandria, and produces, in its native country, a very fine and high-priced raisin. As tried in California it does not maintain its local reputation. Vines have been sent to distinguished ampelographers of Europe, who are inclined to doubt the distinctness of the Huasco, but all authorities agree respecting the unique excellence of the Huasco raisin. There is, therefore, a wide field for investigation here.

The White Malaga makes a raisin of fair quality that ships better in bulk than the Muscat raisins; being gathered at one crop it is preferred by growers in districts subject to early rains. Still more interesting, because only recently used as a raisin grape, is the Feher Szagos, a large greenish amber sherry-wine grape of Hungary. This notable "White Jack," which the name means, has been grown for thirty years or more in California, but only recently as a raisin grape.

Seedless Sultana represents a very different class from the preceding varieties. It must be pruned long, and then bears enormous crops. The round and seedless berries are an amber-yellow when ripe, with perhaps a brownish tinge in the sun. The yield of grapes has been sixteen tons to the acre, in suitable localities. The raisin made from this grape is slightly, but agreeably, acid. It needs long, warm summers to ripen well.

Another group of seedless grapes, the true currant grape type, comes, like the Sultana, from the Grecian Isles and the shores of Asia Minor. The black currant grape has small berries, black and seedless, and a peculiar, rich aroma. The white and the red varieties, though desirable and free bearers, are less valuable for currants. The black variety has not yet been planted to any great extent in California, as the proper locality for it has not yet been discovered.

Thompson's seedless grape is one of the most popular of all the raisin varieties and presents an interesting problem to the horticulturist. It is not known whether it is a new variety or not. It appeared in a vineyard near Yuba City, Sutter County, and was extensively propagated as a seedling. Upon investigation, a horticultural committee reported that the parent vine was thought to have come in a shipment received from Ellwanger & Barry, of Rochester, in 1872. The name given was Lady de Coverly, and the grape was said to be of Turkish origin. Messrs. Ellwanger & Barry stated, upon inquiry, that no such grape was in their catalogue, nor had been grown by them. I have examined Count di Rovasenda's great book on "Ampelography" (1887 edition), also Monsieur Pulliat's works, and cannot find any such name or synonym, nor any grape that corresponds to the Thompson seedless. Like the California Zinfandel, and the old grape of the Spanish Missions, Thompson's seedless appears to be unknown in Europe. Perhaps as our importations of grapes from Asia Minor continue we shall find the original of it. Mr. Eisen, in his book on "The Raisin Industry," suggests Damascus as the probable home of the type.

This grape is perfectly seedless, and very popular for culinary purposes. It is larger than the seedless Sultana, and the raisins it produces are of better quality and sweeter. One pound of raisins is usually made from 3·27 pounds of ripe grapes. The oval, greenish yellow berries are produced in enormous clusters that fairly cover the canes. Long pruning is essential. This variety, now more largely planted than any other sort, was poor for years under the ordinary short pruning given to Muscats and Malagas. Mr. J. P. Onstott, of Yuba City, lately reported the yield of groups of vines of this variety in his vineyard. In 1888, nine vines averaged eighty-nine pounds apiece; the same vines, pruned short, yielded thirty pounds apiece. Five vines in 1891 produced 516 pounds. Six two-year-old vines, still in nursery-rows, standing eight feet apart each way, produced an average of forty and a half pounds apiece. One vine yielded fifty pounds in 1885, sixty-eight pounds in 1886, seventy pounds in 1887 and 109 pounds in 1888. Then it was pruned short, and the yield of 1889 was only fifteen pounds. The next year, 1890, it was still suffering, and without bearing wood, and only bore twenty-four pounds. In 1891, being fully recovered, the crop of this vine was 147 pounds. It should be noted that all the vines tested stood in a vineyard, and were eight feet apart each way.

As I have said, this new grape of unknown parentage presents many valuable features, and is planted largely both for raisins and table use. The fact that a change in the method of pruning caused its good qualities to be recognized, seems to me worthy of especial note. Practically speaking, the variety was picked up in a long-neglected vineyard, and has become famous under the treatment of an intelligent vigneron. — *Charles Howard Shinn in Garden and Forest.*

THE FORMATION AND DEFORMATION OF MINNESOTA LAKES.

By C. W. HALL, Minneapolis, Minnesota.

IN respect to inland waters Minnesota shows conditions which are exceptional in North America. Exclusive of that portion of Lake Superior within her boundary, the State has 5,700 square miles of lakes varying from a few acres to the size of Red Lake, which has 340,000 acres in its area. These lakes are conveniently divided into three classes.

First, rock-bound lakes. These bodies of water occur chiefly in the northeastern portion of the State. They occupy the troughs in the crustal folds that have contorted the surface, or the depressions where excessive faults have broken and considerably tilted the strata. These, as a rule, are long, narrow, and deep. The water is clear and sparkling, abounding in fish, and remarkably free from the various forms of plant growth peculiar to shallow waters.

Second, silted river lakes. These lakes occur in rivers where rapid streams have brought down a deposit into the channels of the more sluggish ones, the silting debris being so coarse that the slower current fails to transport it. Thus slower streams are choked up and the water set back for miles. Such lakes are Lake Pepin, formed where the sluggish Mississippi is dammed by the debris brought into its channel by the more rapid Chippewa River, Lake Saint Croix, Lake Lac qui Parle, and many others.

Third, glacial lakes. If this group could be minutely subdivided, there would be seen several types of lake formation. Those of the Lake Agassiz type, where one portion of the shore consisted of a wall of ice, have long since disappeared and left scattered pools of varying sizes, occupying the depressions in the generally level surface of the old lake bottom. Going outside of the State for an illustration, we may name Lake Winnipeg as the largest pool now remaining in the bottom of glacial Lake Agassiz. Many other lakes are scattered over the level portions of the

State, occupying the depressions in the drift sheet where this was laid down evenly through the steady and uniform movement of the ice, or through the silting effect of waters due to the melting of the ice border.

But by far the greatest number of lakes in Minnesota are those occupying the depressions in the unevenly distributed morainic matter deposited during glacial times. Portions of the State are thickly studded with these beautiful sheets of clear water. The region between Minneapolis and the Red River valley is appropriately called the Lake Park Region, as lakes occur here in vast numbers. Wright County, nearest to Minneapolis, contains 259 lakes, Kandiyohi County contains 286, and Ottertail County, well up toward the borders of glacial Lake Agassiz, holds the banner over 430 lakes. Passing northeastward from the Lake Park Region toward Ontario, past the headwaters of the Mississippi, and across the upper streams of the St. Lawrence River basin, we pass gradually from the region of moraines to the region of thin glacial deposits and constant and tumultuous rock exposures, carrying large numbers of lakes of the first type.

It has been frequently estimated that Minnesota contains 10,000 lakes. To one passing over the State through the region named this does not seem an exaggeration. There must be several thousand lakes from one mile in length upward to the very largest.

While glacial lakes show many varieties of form due to the position of tongues, branches, and subdivisions of the moraines, they are generally circular in outline. The deepest portion is at the center. Their shores show but few successive beaches to indicate erosion at their outlets and consequent drainage, or great variation in the amount of rainfall during the last few thousand years. They were all evidently formed in the same general manner, by the washing down of fine silt from the high land into the bottom, thus gradually filling the interstices in the gravels and sands beneath them, making water-tight bottoms to hold the water. Probably the lakes were small at first, and enlarged gradually as this deposition of fine silt extended their borders until the lowest point in the margin was reached and an outlet drained away the excess of water. When this outlet was reached the conditions of formation ceased, and the conditions of deformation became manifest. Material was constantly washing in from the high lands around through the melting snow of successive springs and the heavy showers and rain storms of the summer months; it was also brought by streams flowing into the lakes from every direction, and formed *in situ* by the vigorous growth of aquatic vegetation. In the shallower lakes this last cause of deformation works with great rapidity. After the ice disappears in the spring under the warm sun of this latitude the water very rapidly rises in temperature to 70° or 75°, a favorable temperature for vigorous vegetable growth, and thus plant forms which can get foothold upon the lake bottom will develop a vast amount of plant debris. Already hundreds of the shallow, small lakes of the State have disappeared, and rich, productive hay meadows have taken their place. This will be the fate of thousands more within the coming century. On every hand we hear old settlers speak of large lakes once affording superb hunting ground for wild geese, ducks, and other water fowl and excellent fishing, as now either hay meadows or extensive marshes soon to be fitted for hay production by a further lifting of the surface above the level of the outlet through this rapid accumulation of the vegetable mould.

The lakes of Minnesota afford some of the most attractive summer resorts to be found in our northern States; as already famous can be mentioned Minnetonka, White Bear, the Chisago Lakes, and Waconia. The list can be indefinitely extended. Their climatic influence is very marked. The amount of heat stored up during the summer, if calculated by its mechanical equivalent, is enormous. With 43° as the average increment in temperature, 10 feet as an average depth of 5,700 square miles of water surface, we have nearly 11 cubic miles of water. Since each cubic foot of this water receives 1,250,000 foot pounds of heat, which must be given off during the autumn months as these lakes gradually settle down to the freezing point of winter, the amount of heat thus made available for our autumn weather reaches quintillions of foot pounds. This warmth is a break against early autumn frosts. The south side of Lake Minnetonka has most productive vineyards and fruit gardens, while the northern side is liable to early frosts.

Other writers have called attention to the distribution of fresh water lakes. They are almost wholly confined to the glacial regions of our globe. Northern Europe and northern central North America, with other isolated portions of the globe, are the only places where many bodies of fresh water are found. It remains to be noted that within these glaciated regions the oldest portions are already comparatively free from lakes. The southern border of the glacial area of the United States is almost wholly devoid of them. The vast prairies of Ohio, Indiana, and Illinois have but few, yet there are vast agricultural tracts within these States which show deep and rich accumulations of vegetable mould, evidence of former aquatic plants. Doubtless there were once thousands of lakes within these States, but the silting in of mineral debris and the growth of vegetation have filled them up, and thus altered the whole face of the country, a result soon to be very marked within Wisconsin, Minnesota, and the Dakotas. Indeed, the years can almost be counted when glacial lakes within these States will be rare indeed.

The question how long a period of time has elapsed since the retreat of the glacial ice sheet from the central portion of the North American continent cannot be here discussed. Yet, by way of suggestion, it may be said that, if the filling up of glacial lake basins be a chronometer useful in measuring geological time, the rate at which these lake basins are now filling up and disappearing, and the fact that they have already disappeared from the southern portions of the glaciated area, are strong presumptive evidence that the ice of the glacial period lingered longest in the region between Lake Michigan and the Missouri River to the north of the 44th parallel, and that here the time since its disappearance has been comparatively brief; indeed, that the estimates of Gilbert, Wright, Winchell, Upham, and others are long enough to explain every phenomenon save, possibly, that of the redistribution of plants.

The two remaining lake types are more permanent. Rivers will continue to be silted and their currents choked so long as two streams of varying transporting power merge into one. Rock basins will continue to hold water so long as the conditions of erosion are unfavorable through the obdurate resistance of crystalline rocks, and plant growth is discouraged through the lack of soil, as is now the case around the margins of the rock basin lakes of northeastern Minnesota.—*Science.*

HOW TO BANDAGE A FINGER.

By S. GEO. HERMANCE, M.D., Rochester, N. Y.

THE bandage ordinarily put on a finger is unsatisfactory. It gets loose, slips off, and is generally bungling from superabundance of material.

I have used the following described bandage for some years with much satisfaction, especially for fingers caught between bumpers in coupling cars. This bandage remains firm while the hand is in use. A man with a pinched finger often returns at once to work.

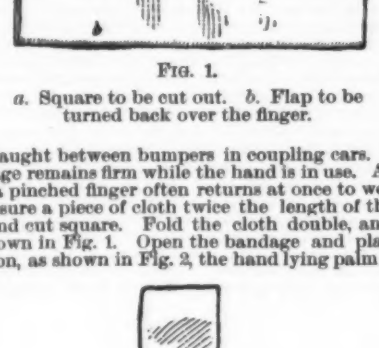


FIG. 1.

a. Square to be cut out. *b*. Flap to be turned back over the finger.

Measure a piece of cloth twice the length of the finger, and cut square. Fold the cloth double, and cut as shown in Fig. 1. Open the bandage and place in position, as shown in Fig. 2, the hand lying palm down on your knee. Then turn down the flap over the finger and tie the first set of tails over it in one knot, leaving the ends loose, to be covered by the tying of the second set of tails. (See Fig. 3.) The remaining tails are tied in the same way, making a double knot in the last set. In tying the tails draw them snug, but not too tight. This makes a neat, firm and very satisfactory bandage. When once used it will demonstrate its advantages.—*International Journal of Surgery.*

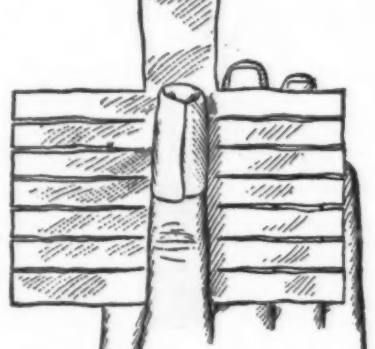
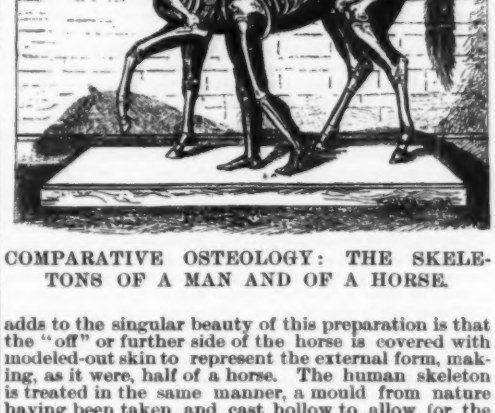


FIG. 2.—BANDAGE IN POSITION.

FIG. 3.—FIRST TWO TAILS TIED.

SKELETONS OF MAN AND HORSE.

SOME of the most interesting objects in the fine series of comparative osteology in the great hall of the British Museum at South Kensington, now in course of formation, by the director, Professor Sir William Henry Flower, K.C.B., F.R.S., are fine mounted skeletons of a horse and of a man. These are so lettered and figured that a ready comparison may be made between the respective parts in the skeleton of the one and the other, and very curious and extraordinary modifications in structure are at once apparent to any one after a few minutes' examination. Let us take, for instance, the forelimb of the horse: it is quickly seen that the *scapula* (shoulder-blade) and *humerus* (arm-bone) have many points in common with those parts in man—the change being mainly in form, and due largely to the horse's horizontal position, extra work being thrown on the shoulders and forelimbs. At the elbow-joint, however, a fusion between the fore-arm (*radius* and *ulna*) takes place in the horse; in man these bones are distinct and freely movable, especially at the wrist. In the *carpus* (wrist bones) of the horse a further reduction in the number of bones as compared with man takes place, but it is especially in the bones which constitute the hand in man (*metacarpus*) in which extraordinary modifications will be noticed. It will be apparent that what is popularly known as the knee in the horse's foreleg is not the knee, but the middle finger in the human hand, greatly developed and strengthened to sustain the enormous weight of the horse's forequarters. It has the same number of parts as the human middle finger, and is terminated by the hoof, which corresponds to the nail of that finger. Examine this long bone a little closer and it will be observed that there are two narrow bones, one on each side, which, on reference to the human hand, are found to be the vestiges of the second and fourth finger greatly reduced. Similar modifications take place in the hind limb of the horse as compared with man's leg. What



COMPARATIVE OSTEOLOGY: THE SKELETONS OF A MAN AND OF A HORSE.

adds to the singular beauty of this preparation is that the "off" or further side of the horse is covered with modeled-out skin to represent the external form, making, as it were, half of a horse. The human skeleton is treated in the same manner, a mould from nature having been taken and cast hollow to allow for the fitting in of the bones forming the man's skeleton. To the artist, draughtsman, teacher or student in comparative zoology this unique preparation is most valuable. Our illustration is from a drawing by Mr. R. E. Holding.—*The Graphic.*

LEMONS IN SUMMER.

THE full value of this fruit is not yet generally appreciated. As a cure for rheumatism and preventive of scurvy, it forms a part of the stores of every ship. In fevers it is invaluable, cooling the blood, allaying thirst and checking nausea. Persons living in malarial countries keep off the dreaded disease by drinking hot lemonade every morning before they leave their rooms. Many a sore throat is nipped in the bud by eating a lemon baked with brown sugar or molasses, and almost every one knows that a hot lemonade, taken at bedtime, with an extra allowance of covering afterward, will break up a cold that has not been of long duration.

Lemonade made with boiling water is better than that made with cold, and its medicinal value is increased by the use of the rinds. Pare off the thin, yellow rind, reject the white skin and seeds, and pour over boiling water. When cold, sweeten and use.

Last summer it was my fate to be considerably more than "ten miles from a lemon," or from anything else, in fact, as I summered on an island in Narragansett Bay, where Providence was the nearest point of supplies. Consequently, when a visiting friend brought me a hundred fine lemons, I valued the gift and took every means for preserving them, as well as for using them in the greatest variety of delicious ways. As fruit on this island was scarce, my lemons were a valuable substitute. Among the receipts successfully tried were these:

LEMON BUTTER.—Beat together the yelks of five eggs, one pound of powdered sugar and four ounces of butter, until very light; stir in the whipped whites of four; pour into a double boiler and stir until it thickens, when add the juice of three lemons and the grated rind of one. Turn into a bowl to cool, or put up in tiny jars. Delicious with thin bread and butter for afternoon tea.

LEMON WATER ICE.—Even on our cool island there were hot days when we welcomed this confection. Boil a quart of water with a pound and a quarter of sugar, the yellow rind from three lemons and from one orange if you have it, for five minutes; then stand away to cool. Squeeze into this the juice of four lemons and one orange, or a gill of currant or strawberry juice may be added instead of the latter; turn into the freezer and freeze.

LEMON SPONGE.—Cover one box of gelatine with a cupful of cold water and soak for an hour; pour over a quart of boiling water and a cupful of sugar and stir until dissolved; strain into a basin and set on ice, stirring occasionally until cold, when add the whites of eight eggs whipped to a froth; turn into a pudding mould to set and serve with a sauce made of one pint of milk, brought to a boil in a double boiler; add the yelks of four eggs and two tablespoonfuls of sugar; stir for two minutes, flavor to taste and remove from the fire.

LEMON CUSTARD.—Sift a tablespoonful of flour into a bowl, add the yelks of five eggs, one at a time, beating as you add each; then butter the size of half an egg, melted, then the grated rind and juice of one large lemon, a cupful of sugar, and by degrees three cupfuls of sweet milk, stirring constantly. Bake in

two pie dishes lined with crust; beat the whites with three tablespoonfuls of powdered sugar to a stiff froth, and spread over the top when nearly done; return to the oven to color a pale brown.

LEMON PUDDING.—Beat a cupful of butter to a cream, adding gradually the yelks of ten eggs, two whole eggs and the juice and grated rind of three lemons, one cupful of finely chopped almonds, one cupful of sugar, and lastly the whites of the eggs whipped stiff; line a large dish with rich crust, pour in the mixture and bake one hour, or bake in two one-quart pudding dishes.

ANOTHER.—A quarter of a pound of stale sponge cake crumbled into bits, the juice of four lemons, the grated rind of two, one and a half cupfuls of sugar, a pint of cream, the yelks of six eggs and whites of three. Bake in two pudding dishes lined with crust for half an hour.

LEMON SIRUP.—This is an article to make when lemons are twenty-five for twenty-five cents. Grate the rind of sixteen large lemons, over eight pounds of granulated sugar; add the juice and two quarts of boiling water; stir until the sugar is dissolved; strain through a fine flannel bag and cork up in pint bottles.

LEMON PIE.—Beat the yelks of three eggs to a cream, add the grated peel and juice of one fine large lemon; put half a tablespoonful of butter over the fire in a small saucepan, and when melted add the yelks and lemon juice; stir to a creamy thickness; remove from the fire, and when cold mix with one cupful of sugar and a beaten egg; line a plate with crust, brush over with the white of an egg, sprinkle with fine crumbs, put in the mixture, cover with a thin crust and bake in a medium oven. This is a delicious pie if rightly made.

LEMON CREAM CAKE.—Stir together half a cupful of butter and one of sugar; add the juice and grated rind of one lemon; then three whites of eggs whipped to a froth alternately, with one and a half cupfuls of flour sifted, with a teaspoonful of baking powder and half a cupful of milk. Bake this in two jelly tins. For the filling, boil three-fourths of a cupful of milk with two tablespoonfuls of sugar; dissolve a tablespoonful of cornstarch in two tablespoonfuls of cold milk, stir into the boiling milk and cook for ten minutes in a double boiler; add a generous lump of butter, the juice and grated rind of a lemon and the yelks of three eggs; stir until it thickens, and remove from the fire. When cakes and filling are cold, spread this between the layers.

LEMON ESSENCE.—When one is using lemons plentifully, an excellent essence may be made at the slightest cost. Put the grated rind of a dozen lemons into a pint of alcohol, add a teaspoonful of lemon oil, bottle and cork tightly and set in a warm place; shake every day for two weeks, when it will be ready for use.

LEMON BISCUIT.—Beat the yelks of nine eggs with the weight of the eggs in powdered sugar; add the juice of two lemons and the grated rind of one; then, a little at a time, the weight of the eggs in sifted flour, and lastly the whipped whites. Bake in small gem pans.

Receipts might be multiplied indefinitely. Lemon juice is superior to vinegar for making a mayonnaise. Iced tea in summer with a slice of lemon is a most refreshing drink, and will prevent the loss of sleep that is sometimes caused by a too intemperate use of tea taken in the ordinary way.

If the hands be rubbed with a cut lemon every time after washing, particularly when one is engaged in any work which stains them, they will keep white and soft.

To keep lemons, cover them with fresh, cold water, and change every week. They ripen and become more juicy, and may be kept in this way for several months. —*Alice Chittenden, in the Country Gentleman.*

EFFECTS OF SULPHUR ON CLARIFICATION.*

By Prof. J. T. CRAWLEY.

THERE is probably no question connected with sugar manufacture about which there is such a diversity of opinion as the use of sulphur, notwithstanding the fact that it has been used and studied so extensively. In looking over the literature of the subject, one is struck with the divergence of conclusions reached by chemists and manufacturers from experiments, both in the laboratory and in the sugar house; indeed, we may often find almost identical results reached by two different experimenters, while conclusions drawn are diametrically opposed. The chief advantages claimed for sulphur are three—namely: (1) it decolorizes; (2) it clarifies; (3) it prevents fermentation; although some have heralded it as a panacea against all accidents and misfortunes to which sugar products are liable.

1. SULPHUR AS A DECOLORIZER.

Sulphur is used very extensively in the arts as a decolorizing agent, and it accomplishes this effect both by uniting with the coloring matter to form colorless compounds and by taking away oxygen from coloring matters, thus reducing them to colorless compounds.

When this latter action takes place, the sulphurous acid is oxidized to sulphuric acid. The hydrogen that is thus set free unites with the coloring matters and reduces them to compounds less colored.

As sulphuric acid is a stable body this decolorizing effect is apt to be permanent, provided the compounds be not oxidized again. If, on the other hand, sulphurous acid acts by combining with the coloring matter, accidents may break up this combination, when the color will reappear. In fact, it is usually the case that sulphur acts but temporarily, as we shall see upon further study of our subject.

Where sulphur is used in sugar manufacture, the chief aim is the decoloration of the juice, sirup or other product, and therefore this is the most important part of the subject. The use of sulphur is almost as old as the sugar industry itself, and we find its use recommended by such men as Walkoff and others—men who, it might be said, are founders of the sugar industry. Sulphur can be added both in the form of sulphites of soda, lime, etc., or in the form of free sulphurous acid, and the decoloration is much better when added to acidity.

L. Battut (*Bull. de l'Association des Chimistes*, 1894, p. 132) cites an experiment which shows this fact very well. Fifty cubic centimeters of a 5 per cent. solution of SO_2 was added to a liter of juice. A voluminous precipitate was produced which settled easily, leaving the supernatant liquid clear and almost colorless. Milk of lime was then added to neutrality, there was a new precipitation of coloring matter by the lime, but the juice became more colored, showing that the compounds originally produced with SO_2 had been at least in part broken up and the coloring matter reappeared.

It seems that when sulphurous acid is added to juice a precipitate of coloring and nitrogenous matters is formed, but that it redissolves when the juice inclines to alkalinity. To test this question further, Battut made the following experiment:

Two liters juice were treated separately by SO_2, and the precipitates formed separated from the liquid. One of these was heated for twenty minutes with 50 c. c. of a twenty per cent. milk of lime and 300 c. c. of the filtered juice. After treatment with milk of lime and carbonatation, the precipitate was separated and the juice analyzed. In the second case the precipitate formed by SO_2 was separated, and the remaining juice limed, carbonated, filtered and analyzed. It was found that when a filtration intervened between sulphuring and liming a juice of higher purity resulted. Battut, in an excellent memoir on this subject (*Bull. de l'Association des Chimistes*, 1890, p. 176), compared the decoloration produced by SO_2, and other acids, such as muriatic, sulphuric, etc.

Samples of beet juice were made acid with equivalent quantities of sulphurous, muriatic and sulphuric acids, and the resulting solution compared as to color as follows:

Sulphurous acid	1
Muriatic	2
Sulphuric	2½
Original color of juice	3½

Thus it is seen that the color of the original juice was destroyed to a considerable extent by the two latter acids and almost entirely by sulphurous acid. From several experiments of like import the author concludes:

The decolorizing effect of sulphurous acid comes both from its acidity and from its reducing action.

It is a matter of common observation in sugar manufacture that acid juices, no matter what their acidity is due to, are lighter colored than alkaline juices, and also make brighter sugar. In attempting to isolate the acids contained in sugar cane I have been struck with the difference in color between different solutions containing acids together with coloring matters. In neutralizing these solutions with ammonia or milk of lime they often were of a perfectly black color, but this color was changed to a light amber on acidifying with any of the common mineral acids.

Part of the effect of SO_2 then is due to the fact that it is an acid, but from the above experiments we see that there is a further decoloration due to the peculiar properties of this acid. The great danger in the use of sulphurous acid lies in its destructive effect on sugar when used in excessive quantities. If juices made acid with SO_2 be heated before liming a great inversion will result, and if these same juices remain in contact with the air, sulphuric acid is formed from the oxidation of the sulphurous acid both by the air and the organic matter contained in the cane juices.

There is a considerable diversity of opinion as to the point where sulphurous acid should be employed, but theory would suggest that it should be applied at a point as near to the crystallization of the sugar as possible. When it is applied to the juice, and these juices are limed either to neutrality or alkalinity afterward, its effects are, to a considerable extent, destroyed, and it will be found that the coloring matters will gradually reappear during the concentration in the triple effect and in the vacuum pan. Again, if sirup or masse cuite be diluted until it has the same density as the original juice it will have a deeper color than the juice, thus showing that coloring matter has been developed during the concentration. It would seem then that the sulphur should be applied after all the coloring matter has appeared, so that it would have its greatest effect.

In Seyfert's process as recommended by him in 1869, the SO_2 was drawn into the vacuum pan during the evaporation to masse cuite, the vacuum in the apparatus serving to draw the gas into the solution. This, however, gives considerable trouble, inasmuch as there is no way of judging of the alkalinity or acidity of the solution, and it disturbs the pressure in the vacuum pan. For these and other reasons this process has been generally abandoned, and many prefer to sulphur the sirup as it comes from the last of the triple effect.

2. SULPHUR AS A CLARIFIER.

As was said in the beginning of this paper, SO_2 on being added to raw juice produces a precipitate, which is composed in part of nitrogenous substances contained in the juice; and therefore the use of SO_2 should raise the purity. When applied to sirup also a precipitate is formed, which in beet factories is allowed to settle, or is filtered off. The general opinion, however, seems to be that the acid is not very valuable as a clarifier, and were this the only good result from its use it would scarcely repay the cost and labor expended in its application.

3 SULPHUROUS ACID AS A PREVENTIVE OF FERMENTATION.

The antiseptic properties of sulphurous acid and sulphites have long been known, but it does not seem that sugar manufacturers have given due credit to this agent in the sugar houses. They are accustomed to look upon the decolorizing effect as the only good to be attained, and neglect to observe if juices treated with sulphur keep better than do those which have not been so treated. A great many experiments have been performed, which go to prove absolutely that this agent tends to prevent sugar products from fermentation. It is well known that juice from unsound canes—canes that have lain in the rain for a long time, or have been bruised, or that have been frozen—are specially liable to fermentation, and I would suggest that a great saving would result from a judicious application of sulphurous acid to the juices. Toward the end of the season, when a great many canes are injured by windrowing, freezing, rains, etc., it is seen that the yield of sugar per ton decreases very greatly, due in part to fermentation; and by this time, unless special care has been taken in keeping the sugar house and all apparatus clean, there is an accumulation of bacteria, the deadly enemy of sugar, giving rise to a number of different kinds of fermentation. Sulphurous acid would commend itself in the treatment of these juices in that it is a destroyer of bacteria.

Following are some experiments and results obtained by M. Battut in the memoir referred to above. Juices of second carbonatation were taken. To No. 1, SO_2 was added; No. 2, 1 gramme caustic potash per liter; No. 3, nothing added.

These solutions were left 136 hours at the ordinary temperature, and submitted to analysis with the following results. Sucrose at beginning of experiment=12·37 per cent.

	1 SO_2	2 K_2O	3 Nothing.
Sucrose	12·08	11·98	7·39
Loss of sucrose after 136 hours	0·29	0·39	4·98

Like experiments at a temperature of 40 deg. C. showed a much greater loss of sugar in alkaline juices.

From these and other experiments the author concludes that the sulphurous acid added to the cold juices retards notably the fermentation; when it is added to acidity, the preservation is complete; added to hot juice (40 deg. C.), its antiseptic properties are equally apparent, even when not added to neutrality, but when added to acidity the preservation from fermentation is complete, but there is inversion of sugar.

Following are conclusions reached by Dr. Stubbs from carefully conducted experiments, both in the sugar house and in the laboratory (see Bulletin No. 10, Louisiana Sugar Experiment Station):

"Sulphur is burnt and converted into sulphur dioxide, one part uniting with two parts of the oxygen of the air to form a gas which has an irritating odor, but with bleaching and antiseptic powers. Pure water dissolves under ordinary pressure 43·5 times its own volume of this gas. Cane juice under the same conditions absorbs 33. A solution of this gas exposed to the air absorbs oxygen and is gradually converted into sulphuric acid.

"In Louisiana this gas is forced by machinery into the cane juice as it comes from the mill. Laboratory experiments indicate that one ounce of sulphur suffices for the perfect clarification of 300 gallons of juice. Yet in daily practice this is greatly exceeded. Sulphured juices should be handled with great care and skill, since this gas is an acid, which in itself has the power of inverting sucrose, and further, is easily converted into sulphuric acid, a most energetic destroyer of sugar. Sulphured juices should, therefore, be worked as early as possible, and never heated before being limed. It is a good practice to run a small quantity of lime water into the juice at the mill before sulphuring to unite with and render insoluble any sulphuric acid formed in the combustion of sulphur and which has escaped the wash water. Sulphur acts upon the juice in three ways.

"1. It temporarily arrests fermentation.

"2. It temporarily decolorizes.

"3. It assists in rendering coagulable a portion of the albuminoids.

"Against these good offices are to be placed the constant danger of inverting sugar, the decreased yields, the difficulty of cooking its sirups without filtration, the difficulty of preserving sugar made by its use and the formation of sulphates and sulphites in the juice, which interfere with the crystallization of sugar and the deposition of scale upon the apparatus in which the juices are cooked, due to the formation of double sulphates. The last objection is especially troublesome where neutral juices are worked. Sulphur has been used in sugar manufacture from the raw juice to the masse cuite in the pan, and in all forms, from the pure gas and its solution in water to every one of its salts."

In conclusion I would say that the opinion of those in a position to speak authoritatively is: (1) That sulphurous acid carefully used is of considerable assistance in brightening sugar products and in arresting fermentation; this latter effect being particularly seen toward the end of the campaign, when the products are specially liable to fermentation. (2) That sulphurous acid should be used carefully and always under the supervision of a technical director, who is able to keep it under control and decide when the good effects are greater than its evil effects.

PINE NEEDLE OIL.*

By J. BERTRAM and H. WALBAUM.

UNDER the general name of pine needle oil ("Fichtennadelole") are comprised the volatile oils of the needles and young shoots of various conifers belonging to the genera *Pinus*, *Picea*, *Abies*, and *Larix*. Our knowledge of the chemistry of these oils is still very imperfect; with some few exceptions there have been no complete investigations of them, and it has hitherto been customary to consider only certain of their physical characters, such as specific gravity, optical rotation, boiling point, and the detection of particular terpenes. For distinguishing between the needle oils and turpentine oils the odor has been the chief criterion, and only in a few instances determination of the rotatory power offered the means of ascertaining the presence of considerable amounts of lævolimonene in some kinds of pine needle oil.

Under these circumstances it is not remarkable that the material met with in commerce as pine needle oil has often been nothing more than turpentine oil to which a pine needle oil odor has been communicated by distillation over coniferous needles or by admixture of some true pine needle oil. A practical examination of genuine pine needle oil was, therefore, desirable, and, operating upon material of unquestionable origin, the authors have determined the physical characters and constituents of several of these oils, so far as the present state of science will allow.

It has been ascertained that in almost all kinds of

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* Abstracted from *Arch. der Pharm.*, 231, 270-303.—*Pharm. Jour.*

pine needle oil esters of borneol are present, chiefly the acetic ester, and this may be regarded as the substance to which the peculiar pine odor is due. The particular character of these oils is determined also by the presence of different terpenes. Among these there have been found lævopinene, dextropinene, lævolimonene, dipentene, phellandrene, and sylvestrene. Most of the oils also contain the sesquiterpene named by Wallach cadinene.

The oil of *Abies pectinata*, D. C., is extracted in Switzerland and the Tyrol from the needles and young shoots of the pine. It has a very agreeable fresh odor, and is, therefore, largely used as a perfume.

The oil has a specific gravity of 0·875 at 15° C., and it is lævorotatory for a column of 100 mm. + 20° 40'.

Distilled under ordinary pressure, 8 per cent. passes over between 158° and 170°, 55 per cent. between 170° and [185°; decomposition then commences, since the bornylacetate present can only be distilled *in vacuo* or by the aid of steam.

Naturally the boiling point of an oil liable to undergo decomposition by heat cannot give any indication of its composition. In this instance the liberated acetic acid converts part of the terpene into dipentene, terpinene, and polymeric products, by which the boiling point is raised. A determination of the boiling point serves, however, to distinguish genuine oil from those kinds which consist chiefly of turpentine oil, and, therefore, distill over completely below 170° C.

To ascertain the nature of the constituents of this oil, it was heated for some hours with a sufficient quantity of alcoholic potash, and then fractionated by means of steam.

From the lowest boiling portion, frequently rectified over sodium, pinene was obtained boiling at 157° to 160°, optical rotation — 32°. Refraction for the line n_α 1·4658. For further identification it was converted into the very characteristic nitrosochloride and nitrolbenzylamine compounds.

The fraction boiling from 170° to 180° was lævorotatory, and when bromated gave a large quantity of limonene tetrabromide, showing the presence of lævolimonene.

From the fraction of higher boiling point (190° to 240°) crystals were deposited on cooling which melted at 206° to 207°, after recrystallization from petroleum spirit, and had all the characters of lævoborneol. The portion boiling above 240° consisted almost entirely of sesquiterpene.

The acid separated by saponification consisted chiefly of acetic acid, and the amount of bornylacetate was found to be 4·5 per cent.

Operating in a similar manner with samples of other oils, the following results were obtained:

The oil produced in Switzerland and in Thuringia from the young cones of *Abies pectinata*, D. C., is also met with in commerce under the name of pine needle oil. It differs from the oil previously referred to in its mild odor, low specific gravity, and greater rotatory power. The Swiss oil examined by the authors had a sp. gr. 0·854, rotation — 72°. Between 150° and 170° 16 per cent. distilled over, from 170° to 185° 76 per cent., and the residue amounted to 8 per cent. The amount of ester in this oil was so small that the separation of borneol was not attempted. The chief constituents are lævopinene and lævolimonene, the latter predominating.

The oil obtained from the needles and young branches of the hemlock spruce in North America is characterized by the large amount of bornylacetate it contains (36 per cent.) The other constituents are lævopinene and sesquiterpene.

Oil prepared by the authors from fresh needles and branches of *Picea vulgaris*, Lk., had a sp. gr. 0·888, rotation — 21° to 40°. It contained lævopinene, lævophellandrene, dipentene, lævobornylacetate (8·3 per cent.), and sesquiterpene.

In the Austrian Alps the needles and branches of *Pinus Pumilio*, Haenke, are distilled on a large scale, and the oil obtained from them is extensively used in soap making and other purposes of perfumery. A sample of this oil from the Pustesthal of 0·865 sp. gr. and — 9° rotation was found by the authors to contain lævopinene, lævophellandrene, sylvestrene, bornylacetate (5 per cent.), and sesquiterpene.

An oil produced in Sweden from the needles of *Pinus silvestris*, L., had sp. gr. 0·872, rotation + 10° 40', and was found to contain dextropinene, sylvestrene, and probably some bornylacetate. The oil obtained by the authors from the needles of this tree growing in Germany had a sp. gr. 0·886 and rotation + 10°. Its composition was similar to that of the Swedish oil.

As a general result of these observations, it appears that all the different kinds of pine needle oil contain pinene. The oils from *Abies* and *Picea* contain chiefly the lævo modification, while those of the ordinary fir contain dextropinene.

It is thought probable that besides borneol other alcoholic constituents may be present in some of these oils, for, while in some instances it is easy to obtain borneol in a crystalline state after saponification in quantity almost corresponding to the amount of ester, in others it cannot be isolated at all, or only in small proportion.

On account of the interest attaching to bornylacetate, the authors have prepared the ester artificially from both lævo and dextro borneol. The lævobornylacetate corresponds in all its characters with the natural ester. The dextroacetate is also distinguishable only by the rotatory power. In a pure state bornylacetate melts at 29° C., and it crystallizes from petroleum spirit in rhombic crystals often an inch long. The borneol esters of acids homologous with acetic acid are very much like the acetate in odor, but it intensely increases with the molecule of the acid constituent. It is probable that one or other of these esters may be present in pine needle oil, together with bornylacetate.

NEUTRAL FAT IN MINERAL OIL.

By Dr. J. KLIMONT.

THE method of LUX for the detection of small quantities of fatty oils in mineral oils does not always give accurate results; and, moreover, is by no means the most convenient of processes. How far the recently published modification of Ruhemann, in which the application of the method to viscid mineral oils is altered by the employment of a higher temperature, improves matters I am not at present able to say. In the meantime I may be permitted to communicate a method which I have been in the habit of using for the detection of fatty oil in mineral oils, down even to 1 per cent.

Fifteen grms. of the oil (previously extracted with warm water if sulphuric acid were present) are heated for one or two hours in a flask containing about 400 c.c., with 100 c.c. of a 10 per cent. solution of potash (not soda) in alcohol; then allowed to cool, treated with about an equal volume of water, and filtered through a moist filter. If the determination is to be a quantitative one (see below), the flask and filter are well washed out with hot water, the filtrate exactly neutralized with hydrochloric acid, and, after complete cooling, extracted in a separating funnel with a small amount of petroleum ether. If fat were present, the aqueous layer, which now contains it in the form of a soluble potassium soap, will produce a flocculent precipitate of calcium soap on the addition of a solution of calcium chloride, which increases on standing.

The method described can also be made quantitative; but it is then advisable to concentrate the soap solution, and the wash water which is added to it, to about 100 c.c. This is then precipitated with chloride of calcium solution, filtered through a paper dried at 100° C. and weighed, washed until the disappearance of the reaction for chlorine with the smallest possible amount of cold water, dried at 110° C., and weighed. If the amount of fat is required, the filter paper is incinerated in a crucible and the calcium oxide weighed. To calculate the amount of fat, the weight of lime is subtracted from that of the lime soap. This weight of lime is then multiplied by 0·774, to satisfy the relation of $3\,CaO : (C_3H_5)_2O_3 = 168 : 180$, and the resulting number added to the amount of fatty anhydride given by the difference between the total weight of lime soap and the lime left on ignition. For instance: 14·2680 grms. of mineral oil were mixed with 0·3315 grm. of castor oil, corresponding to 2·32 per cent.

Amount of lime soap....0·3885 grm.
Amount of lime.....0·0335

Hence the fat present was 0·3808 grm., or 2·66 per cent.

In an industrial product, stated to contain 5 per cent. of olive oil, I found 4·6 per cent. of fat.

The method is not suited for the determination of larger amounts of fat, because the calcium soap easily forms lumps, from which it is difficult to wash out the excess of calcium salts, and is also partially decomposed by water. When, however, the fatty acids—either on account of their small amount or of their greater solubility—cannot be estimated in the direct way, this process may be of value.—*Chem. Zeit.*

SOME PRODUCTS OF CASSAVA.*

By E. E. ELWELL and H. W. WILEY.

SOME four years ago one of us† described a plant which has been grown in Florida for many years under the name of sweet cassava, the botanical name of which is *Jatropha manihot* or aipi. From the analysis made at that time it was found that the plant was valuable for feeding purposes, being very rich in carbohydrates, although rather poor in albuminoids. Lately the subject has been studied to a much greater extent, with the object of preparing as large a number of products as possible from the plant, with the determination of their chemical properties and food values.

A large quantity of the root was obtained from Florida, the bark separated from the root, and each subjected to analysis with the following results:

	Peeled root.		Fiber after removal of starch.	Bark of root.	
	Fresh.	Dry.	Dry.	Fresh.	Dry.
Moisture	61·30	—	—	61·30	—
Ether extract	0·17	0·44	0·30	0·66	1·70
Albuminoids (nitrogen × 6·35)	0·64	1·66	1·02	2·29	5·91
Starch (diastase extract inverted with HCl)	30·98	80·06	64·84	—	—
Fiber	0·88	2·26	10·68	3·63	9·89
Ash	0·51	1·31	1·42	2·02	5·23
Undetermined	5·52	14·27	21·94	29·90	77·27
	100·00	100·00	100·00	100·00	100·00

With the starch in the analysis given above are reckoned also the soluble carbohydrates, consisting almost exclusively of cane sugar, and of which, in an analysis of another portion of the dry substance, as much as 17 per cent. was found. The undetermined portion consists of the digestible fiber and carbohydrates of the pentose series. The pentosans in the fiber were determined by the furfurol process, as modified by Krug, and the amount in the air-dried material was found to be 3·92 per cent., and in the material after the removal of the starch, 5·33 per cent.

The fresh root was found to contain 38·7 per cent. of dry matter, being considerably more than was found in the fresh sample of the previous analysis. Of this 38·7 per cent., 30·98 consisted of starch and soluble carbohydrates.

Experiments were made to determine the yield of air-dry starch which could be obtained from the roots by laboratory work. Two sets of experiments were made. In the first set the roots were pulped on a Pellet rasp used for preparing beet pulp for instantaneous diffusion; 12 kilos. of the unpeeled root was rasped in this way, and the starch separated by washing through a sieve of bolting cloth. The washings and settlings were collected and dried in the ordinary method of starch manufacture. The yield of pure starch was 3,105 grammes, equivalent to 25·9 per cent. of the total weight of the root. The starch was almost absolutely pure, containing only a trace of nitrogenous matter. In the second set of experiments 10 kilos. of the root was ground in a pulping machine used for preparing green fodder for analysis. The pulp was much less fine than that produced by the Pellet rasp. Treated in the same way, the yield of air-dry starch was 2,360 grammes or 23·6 per cent. One of the striking points in connection with the work is that the residue from the starch, which consisted largely of fiber, as will be seen by reference to the above analysis, contained still a large percentage of starch, showing that by the process employed the whole of the starch was not separated from the pulp. The diameter of the starch granules is a little over 0·01 mm., being about seven times smaller than the average of potato starch.

The cassava which grows in tropical regions contains a notable percentage of hydrocyanic acid, so great, in fact, that it cannot be used directly as a food. The so-called poisonous cassava is boiled to expel the hydrocyanic acid before being used for feeding purposes. A careful determination was made of the hydrocyanic acid in the fresh root and the amount was found to be 0·015 per cent. While this shows a considerable quantity of hydrocyanic acid, it is hardly in proportions sufficiently large to be alarming. Nevertheless, any possible danger could be avoided before using the material as a food by subjecting it to a sufficient heat to expel the hydrocyanic acid. The hydrocyanic acid seems to be distributed throughout the pulp, and particularly in the juices which can be expressed from the pulp. No injurious effect from the hydrocyanic acid has ever been observed in the case of animals fed on cassava in Florida.

The bark of the root was also subjected to analysis, as will be seen by reference to the above table. It contained no starch, the undetermined matter being chiefly digestible fiber and pentosans.

The mineral matters extracted from the soil are distributed as indicated in the table. The amount of ash in the root itself is quite low, showing that the cassava plant does not require a soil very rich in mineral constituents. The amount of mineral matter taken from the soil by 100 kilos. of the fresh root is approximately only half a kilo. The albuminous matters are also present in small quantities, being only slightly greater in weight than the ash itself. The plant, therefore, is one which seems particularly suited to feed almost exclusively from the air and water, and hence is one which could be recommended on the sandy soils of Florida as a crop which would require the minimum of fertilization.

COMPOSITION OF THE ASH.

The ash of the peeled root and the bark of the root were subjected to analysis, with the following results:

Analyses of the Ash of the Cassava Root.

Constituents.	Peeled Root.			Bark of Root.		
	A.	B.	Mean.	A.	B.	Mean.
Carbon	0·30	0·31	0·31	0·79	0·77	0·78
Silica (soluble in solution of Na_2CO_3)	0·97	0·91	0·94	10·53	11·36	10·94
Silica (insoluble in solution of Na_2CO_3)	7·15	7·15	7·15	52 99	52·16	53·58
Ferric oxide (Fe_2O_3)	0·66	0·66	0·66	2·46	2·44	2 45
Calcium oxide (CaO)	10 68	10·64	10 64	6·58	6·65	6·62
Magnesium oxide (MgO)	7·36	6·35	7·35	3·31	3·33	3·32
Sodium oxide (Na_2O)	1·12	1·28	1·20	0·84	1·05	0·95
Potassium oxide (K_2O)	41·72	41·54	41·63	14·73	14·68	14·70
Phosphoric acid (P_2O_5)	15·58	15·59	15 58	2·44	2·46	2 45
Sulphuric acid (SO_3)	3·67	3·80	3·73	1·71	1·71	1·71
Carbonic acid (CO_2)	9·15	9·12	9·14	2·53	2·50	2·51
Chlorine (Cl)	2·76	2·75	2·75	1·41	1·42	1·41
Total	101·07	101·10	101·08	100·32	100·53	100·42
Oxygen equivalent to chlorine	0·62	0·62	0·62	0·31	0·31	0·31
Difference	100·45	100·48	100·46	100·01	100·22	100·11

From the above numbers it is seen that the ash of the peeled root is especially rich in potash, almost one-half of the total weight being composed of this substance. The potash is combined chiefly with carbonic and phosphoric acids. In the ash of the bark, as might be expected, silica is the predominant element, more than half the total weight consisting of this substance.

Assuming a yield of five tons of roots per acre, the weights of the important fertilizing materials removed by such a crop can be readily calculated from the data given.

Since the bark forms approximately 2·2 per cent. of the entire root, the total crop would be made up of the following amounts of bark and peeled root, which would contain the amounts of mineral matter given below:

Peeled root	9,780 lb., containing	49·88 lb. ash.
Bark of root	220 " "	4·44 "
	10,000 " "	54·32 "

The more important mineral matters contained therein are:

	Ash from peeled root, 49·88 lb.	Ash from bark, 4·44 lb.	Total ash from 5 tons, 54·32 lb.
	Lb.	Lb.	Lb.
Lime (CaO)	5·31	0·29	5·60
Magnesia (MgO)	3·67	0·15	3·82
Potash (K_2O)	20·77	0·65	21·42
Phosphoric acid (P_2O_5)	7·77	0·11	7·88
			38·72

The less valuable mineral plant foods, that is, those which are of so little note as to require no conservation or addition, amount to 17·60 lb. per acre.

Quite a number of preparations were made from the starch of the root, and among them may be mentioned: First, tapioca; the first portions of starch, washed out, especially, produce an excellent article of tapioca when moistened in the usual way. Second, glucose; both the fresh root and the extracted root yield full theoretical amounts of glucose, and samples of this article were made by the conversion of the starch both by sulphuric acid and diastase. The samples of glucose made from the starch were exceptionally good,

* Read before the Washington Chemical Society, February 9, 1893. Reprinted from *American Chemical Journal*, vol. xv., No. 4.

† Wiley, *Agric. Science*, vol. ii., No. 10, pp. 258 *et seq.*

especially when diastase was used; the glucose in this case containing large quantities of maltose. Commercially it would be more profitable to make the glucose directly from the fresh root, in which case the considerable percentage of cane sugar contained by it would be saved, whereas if glucose is made from the starch the cane sugar is previously washed out. On account of the presence of the bark, however, the glucose made from the whole root is not so fine in quality as that made from the pure starch. Third, alcohol; the glucose on fermentation affords the usual quantity of alcohol. Fourth, cane sugar; a beautiful preparation of cane sugar was made from the water used in washing out the starch. The amount of cane sugar, however, is not large enough to warrant its extraction on a commercial scale from the waters used for washing. It is, however, present in sufficient quantity to indicate that in making glucose it is better to use the whole root as indicated above.

The general result of the analytical work is such as to establish the fact that the cassava is a plant of high economic value and worthy of the attention of those interested in the carbohydrate products of the country.

ON THE INFLUENCE OF THE AVERAGE ANNUAL TEMPERATURE ON THE CHEMICAL COMPOSITION OF SUGAR CANE.

By GUSTAVE MICHAUD, Sc.D., Chemist to the Costa Rican Government.

FEW tropical plants are grown under such a variety of climates as the sugar cane. In Louisiana it does not receive half so much heat as in Singapore. On the high plateaus of Colombia and Ecuador it seems to thrive as well as it does in the lowlands of the same countries. Has the amount of heat yearly received any influence on the chemical composition of the sugar cane, and, if it be so, what is that influence? In his excellent and exhaustive work on the sorghum and beetroot sugar industry,* Dr. Harvey W. Wiley has shown the great practical interest attached to the solution of such questions. Being placed in especially favorable circumstances for the solution of this particular problem, I resolved to undertake the chemical researches hereafter described; and in January, 1893, I solicited the authorization and aid of the Costa Rican government for their prosecution. Thanks to the President of the Republic, Don Jose Joaquin Rodriguez, and to the Minister of Agriculture, Don Jose Vargas, two gentlemen who take a keen interest in agricultural chemistry, every difficulty was overcome in a short time, so that at the end of January I could begin work.

Costa Rica is a tropical, mountainous country, and, therefore, has within a small area a wide range of climates, from that of the torrid up to that of the frigid zone. This little country is closely cultivated from the level of the sea up to the height of 2,000 or 2,500 meters, and such is the value of the soil in the highlands that sugar cane is grown as food for cattle in places so cold as to make the profit of such a crop doubtful in any other part of the world. My plan consisted in getting canes from a certain number of places situated all over the country and ranging from the sea level up to the tops of several of the mountains, and to make a comparative analysis of each sample.

Investigations were so conducted as to eliminate or neutralize as far as possible all factors but one (viz., the temperature) which might produce variations in the composition of the cane. These factors were differences in the value of soils, unequal size of cane, and predominance of certain varieties of cane in certain localities. In order to eliminate the last factor, but one variety of cane was selected for all analyses, viz., the red striped cane (*cana rayada morada*, Costa Rica; *canne rubanée*, French colonies). To reduce to a minimum the differences in the composition of cane grown in different soils, fifty canes were taken in each case from a group of many plantations scattered over a wide surface of several square kilometers, each plantation furnishing from two to twelve canes according to its extent.

To avoid variation of constituents resulting from one place sending smaller cane than another, ripe canes only were selected, the smaller ones being carefully rejected. These precautions and a few others of less importance were embodied in the following printed circulars, which were sent to the governors of provinces or district chiefs who had under their jurisdiction suitable places for gathering canes:

REPUBLIC OF COSTA RICA,
MINISTRY OF AGRICULTURE,
SAN JOSE, ——, 1893.

To the Governor of .....

Sir: In order to make a study of the variations in the composition of the sugar cane as determined by the climate, you are requested to send to the government chemist fifty sugar canes, which you will have gathered in —— and will forward on the — of the present month.

In gathering these canes I beg that the following precautions be carefully observed, warning you that any inaccuracies or omissions may seriously affect the success of the work:

1. That the cane be gathered in several plantations, separated sufficiently from one another. These plantations should be neither much above nor below the level of the village church, and in each case the difference in altitude between the church and the plantation should be approximately estimated and inscribed in the form.

2. That the cane selected be of the red striped variety (the class most commonly grown in the country), ripe, ready for grinding, and never undersized. Avoid cutting canes much larger than those around them, and thus forming an exception to others in the plantation.

3. That the canes be cut below, on a level with the soil, and above, higher than the first leaves, so that the place from which they have sprouted may be clearly seen.

4. That on each estate the inclosed form be filled in.

5. That immediately after cutting the cane be sent by means of —— to the following address: Sugar Experiment Station, Escasu.

6. That a telegram be sent to the government chemist, at the above-named address, advising him at what hour the cane was forwarded.

I am, sir, your obedient servant,
JOSE VARGAS.

The circulars were accompanied by the following forms:

FORM.

—	Name of the owner of the plantation.	Approximate difference between the height of plantation and that of the village church.	Number of canes cut.	Time at which the canes were cut.	Observations.
First plantation.....	..	..	..	..	..
Second plantation.....	..	..	..	..	..
Third plantation.....	..	..	..	..	..
Fourth plantation.....	..	..	..	..	..
Fifth plantation.....	..	.	..	..	..
Sixth plantation.....	..	..	..	..	..
Seventh plantation.....	..	..	..	..	..
Eighth plantation.....	..	..	..	..	..

Time at which the cane was sent from.....
Signature of the governor.....

The cane was taken from ten different towns or villages, situated at different heights, from 10 to 1,810 meters above the sea level, and having consequently ten different climates. The name, height, and average annual temperature of these will be given below.

In most cases, the exact height had been already ascertained by the San Jose Meteorological Observatory. In three cases, Pacaca, San Ramon, and San Antonio, it had not, and I measured it by means of the barometer.

The average annual temperature of Escasu, Cartago, and Limon were the only ones known, the others were calculated by interpolation. This method is sufficiently exact if it be considered that in tropical countries the temperature varies very uniformly with the altitude, and that, moreover, relative and not absolute temperatures were wanted.

After being cut the cane was brought to the mill. To prevent the differences of composition that might have arisen from unequal desiccation during journeys of unequal duration, all the canes were ground exactly twenty-four hours after being cut. In order to strictly observe this condition the cane had to travel in various cases on the back of galloping horses. As a rule it was brought by carts or, when possible, by train. I had previously ascertained that 100 grammes of cane lost, during the first twenty-four hours after being cut, from 1·0 to 1·2 of water, but the variations of this number being insignificant, and the object of my investigation being the relative, not the absolute, composition of sugar cane, no correction was ever made for desiccation.

After their arrival at the laboratory the canes were arranged in order of decreasing size, and the first, the tenth, the twentieth, the thirtieth, the fortieth, and the fiftieth were put aside for the purpose of determining the percentage of water. Then the others were brought to a vertical iron mill moved by two oxen and situated near the laboratory. The mill was previously washed, first with water, second with the juice of a few canes, then all the canes were ground and the juice received in two big twenty-liter glass bottles, which were alternately placed under the spout of the mill, every fifteen seconds. Then a separate analysis of the contents of each bottle was made.

It was thought that in order to get at a clear idea of the action of temperature on the composition of cane and its bearing on the sugar industry it would be necessary to ascertain: First, the percentage of sucrose in juice; second, the percentage of total solid matter in juice; third, the percentage of juice in cane. These three results were arrived at in the following manner:

Determination of the Percentage of Sucrose in Juice.—The apparatus used was a half shade saccharometric polariscope (Schmidt & Haensh make). The contents of both bottles of juice were examined twice; once after defecation and once after inversion. Each number was the average of five readings. The zero of the apparatus being determined in the same manner. The percentage of sugar in juice was thus directly obtained. As to the percentage of sugar in cane, it was calculated after the previous determinations of the percentage of juice in cane.

Determination of Total Solids in Juice.—Twenty c. c. of juice were taken from each bottle with a graduated pipette and poured into two light porcelain dishes. These were placed in a water bath and heated at 96° until their weight ceased to change.

Determination of the Percentage of Juice in Cane.—It has been demonstrated that the water increases in the cane from the base to the top. In order to avoid the errors that might result from this unequal distribution of water, one piece of one decimeter in length was taken from the exact center of each one of the five canes that had been put aside for the purpose of determining water. The five pieces were weighed, placed in a water bath and heated at 96° C. for five hours. Then they were taken off, split, and placed again in the water bath until their weight remained invariable.

By heating them previously to their splitting, part of the water was evaporated and soluble protein coagulated. The result of this was that we could split the cane without loss of juice. The percentage of water in cane being thus ascertained, the percentage of juice was calculated by means of the following formula:

$$T = \frac{1000\,A}{D - E}$$

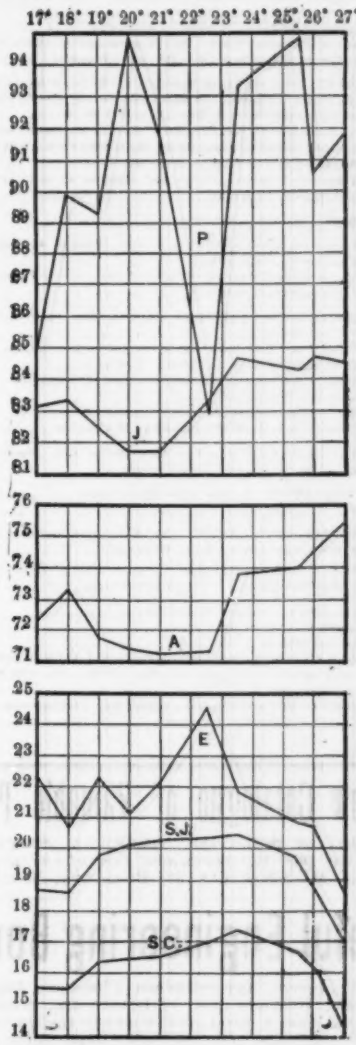
T = percentage of juice in cane.
A = percentage of water in cane.
D = weight of a liter of juice.
E = weight of total solid matter contained in a liter of juice.

These determinations gave the following results:

Place.	Height in meters.	Average annual temperature.*	Percentage of sucrose in juice.	Percentage of water in cane.	Percentage of juice in cane.	Percentage of sucrose in cane.	Percentage of solid matter in juice.	Quotient of purity.
San Antonio.....	1810	17·0°	18·768	72·481	83·158	15·609	22·076	84·998
San Ramon.....	1640	18·0°	18·714	73·237	83·318	15·590	20·798	89·979
Cartago.....	1417	19·0°	19·844	71·960	82·522	16·376	22·306	89·303
Asserri.....	1280	20·0°	20·111	71·337	81·808	16·452	21·307	94·324
Escasu.....	1110	21·0°	20·318	71·294	81·860	16·632	22·097	91·949
Pacaca.....	873	22·5°	20·417	71·330	83·248	16·996	24·602	82·906
Atenas.....	730	23·5°	20·503	73·943	84·797	17·386	21·976	93·295
San Mateo.....	350	25·5°	19·881	74·008	84·380	16·776	20·978	94·7 0
Esparta.....	219	26·0°	18·919	74·608	84·872	16·057	20·864	90·677
Moin.....	10	27·0°	17·084	75·379	84·600	14·453	18·600	91·849

* Centigrade scale.

A glance at these figures or at the following diagram will show that the percentage of solid matter increases regularly while the temperature decreases from 27° down to 22°, then it goes down, but irregularly enough to show the positive influence of the only foreign factor that it was impossible to rigorously equalize in all cases, *i. e.*, difference in the chemical composition of the different soils.



P, quotient of purity; J, percentage of juice in cane; A, percentage of water in cane; E, percentage of total solids in juice; S J, percentage of sucrose in juice; S C, percentage of sucrose in cane.

The percentage of sugar bears nearly the same relation to the temperature as do total soluble bodies, but here variations are more regular and do not present more than one small anomaly. From 17°084 in the hottest place this percentage increases steadily and rapidly as the temperature decreases. When this reaches 22°5 it begins to descend slowly, thus showing that an average annual temperature of 21° to 24° C. is the most favorable to the richness in sugar of cane juice.

As the variations of the temperature have a similar influence on the numerator and on the denominator of the fraction of purity,* they cannot be expected to greatly alter the value of the quotient, and while the variations of this quotient are comparatively great, they do not seem to bear any relation whatever to the variations of the temperature.

The variations of the percentage of water in cane are exactly the reverse of the preceding; when the concentration increases, the percentage of water in cane decreases; and as a result the percentage of juice also. For this reason the variations in the percentage of sugar are not so great in cane as in juice.

The preceding statements may be condensed in the following conclusions:

1. The greatest concentration of cane juice in sugar, as well as in other soluble matter, is found

* "The Northern Sugar Industry," by H. W. Wiley, U. S. Department of Agriculture, 1884.

* The quotient of purity is the percentage of pure sucrose contained in the total solids.

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where the average annual temperature ranges from 19° to 24° C.

2. If the average annual temperature be above 24°, the decrease in the concentration is more accentuated than if it be below 19°.

3. The quotient of purity is unaffected by the average annual temperature, and seems to depend mainly on the chemical nature of the soil.

4. As a rule, when juice is poor in soluble solid matter (sugar included), it is abundant; when concentrated, it is scarce.

5. In these tropical countries where the sugar cane, during its growth, has the advantage of an average temperature ranging from 19° to 25°, a sugar factory is likely to make the best profit out of every ton of cane.

THE CHEMISTRY AND PHYSIOLOGY OF FOLIAGE LEAVES.

A VERY suggestive paper on this subject was read before a recent meeting of the Chemical Society by Mr. Horace T. Brown, F.R.S., and Mr. G. Harris Morris, Ph.D. The work originated in an attempt to discover the explanation of the conditioning effect of "dry hopping"—*i. e.*, the addition to finished beer of a small amount of dry hops. This was ultimately traced to the presence in the hop strobile of a small but appreciable amount of diastase, sufficient to slowly hydrolyze the non-crystallizable products of starch transformation left in the beer and reduce them to a condition in which they can be fermented by the yeast. In endeavoring to ascertain if this occurrence of diastase in the hop strobile was an isolated case or a special example of a widely distributed property of vegetable tissue, the writers were led to inquire into the first formation of starch in the chloroplasts of the foliage leaf, the mode of its dissolution and translocation in the plant, and the nature of the metabolized products. The paper contains a great number of analyses of leaves of various plants, giving the amounts of diastase and sugars under certain conditions, and also a description of new analytical processes. The results obtained are regarded as entirely antagonistic to the assumption made by Sachs that all the products of assimilation at some time take the form of starch. Cane sugar, Messrs. Brown and Morris find, is the first sugar to be synthesized by the assimilatory processes. This sugar accumulates in the cell-sap of the leaf parenchyma when assimilation is proceeding vigorously, and when the concentration exceeds a certain point, starch commences to be elaborated by the chloroplasts at the expense of the cane sugar. This starch forms a more stable reserve material than the cane sugar, and is only drawn on when the latter more readily metabolized substance has been partially used up. Cane sugar is translocated as dextrose and lævulose, and the starch as maltose. From the invert sugar derived from the cane sugar the dextrose is more readily used up for the respiratory processes, and possibly also for the new tissue building, than is the lævulose; hence in a given time more lævulose than dextrose must pass out of the leaf into the stem. An interesting discussion followed, in which the president, Dr. Armstrong, Mr. Thiselton Dyer, Dr. Scott, Professor Green and Dr. Lauder Brunton took part. Dr. Brunton said that this research threw a light, not merely upon vegetable physiology and chemistry, but on the physiology of animal life and also on that of the lowest organisms which could hardly be reckoned either as animal or vegetable. He thought that perhaps animal life in its turn might throw a light on vegetable physiology, and instanced the close resemblance that existed between the storage of glycogen in the liver of animals during digestion with its subsequent conversion into sugar and the temporary accumulation of starch and its subsequent removal from the leaves of plants. It was possible that more than one enzyme might be present in the leaves of plants, and he was anxious to know whether any observation had been made as to the presence of an enzyme in the plant which could decompose sugars.—*Lancet.*

OILS OF APRICOTS, CHERRIES, PLUMS AND PEACHES AS ADULTERANTS OF ALMOND OIL.

By C. MICKO.

THE above-named oils are all fluid at the ordinary temperature and have a yellow color and a mild, pleasant taste recalling that of almond oil, so that they could not be detected in admixture with it by simple inspection. The author has therefore determined the following constants by means of which discrimination is practicable.

		Apricot.	Cherry.	Plum.	Peach.
For the oils.	Specific gravity	0·92108	0·92800	0·91949	0·92147
	Acid number...	0·64	1·11	0·55	0·52
	Saponification...	193·11	193·36	191·55	191·11
	Iodine number..	108·07	114·30	100·20	99·71
	Saponification number	194·04	189·04	200·47	200·67
For the insoluble fatty acids.	Iodine number..	102·64	104·33	104·21	101·98
	Melting point..	13°4—18°C	16—20°6	*12°4—18°1	10—18·9
	Mean molecular weight.....	266·60	266·28	279·34	278·78

1·24 in original.

The iodine absorption is therefore the best single criterion for these oils. Certain color reactions are also given as an aid in detecting them. With nitric acid of specific gravity 1·4, apricot and plum oil give an orange color, peach oil at first a yellowish brown, then a dirty orange; cherry oil gives a dark brownish red color, and the aqueous layer becomes bright red on standing. Bieber's reagent (a mixture of concentrated sulphuric acid, crude nitric acid and water in equal parts) gives a beautiful peach red color with apricot oil, a brown, darkening on standing, with cherry oil, a rose color with plum oil, and with peach oil no coloration for the first half hour, but a bright brown color after the lapse of some hours. It has hitherto been generally accepted that peach oil gives a peach red color, but according to the author's experiments this is not the case, that color being characteristic for apricot oil.—*Zeits. österr. Apoth. Verein*, 1893, xxxi., 175; *The Analyst.*

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